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JULY, 1935

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NEXT MONTH

THE Western Front in Chemical Engineering has come to be synonymous with rapid advance in industry and technology. For years, *Chem. & Met.* has reflected in its pages the variety and extent of those developments. Our first Pacific Coast issue was in November, 1931, when national interest was attracted to a number of outstanding new plants—Trail, Trona, Shell Chemical, Great Western, Hooker and Tacoma Electrochemical—to mention but a few.

NEXT month, simultaneous with the great chemical conclave in San Francisco, *Chem. & Met.* will devote its entire issue to an exposition and inventory of resources and opportunities on the West Coast. Cheap electric power, natural gas and petroleum available at tidewater, and an abundance of natural and manufactured chemical raw materials give this territory a great new interest to chemical engineers. Dr. Paul D. V. Manning and the entire editorial staff of the McGraw-Hill Publishing Co. of California are hard at work in your behalf. Watch for the results of their labors.

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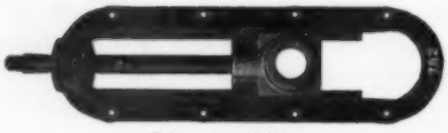

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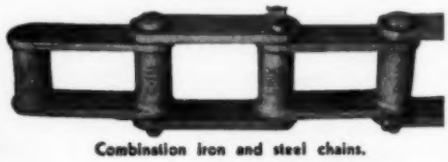

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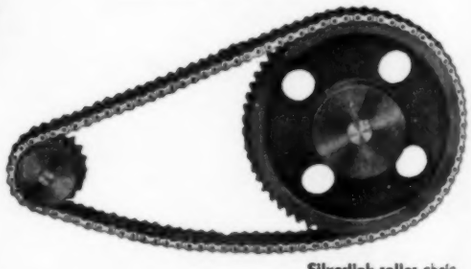

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S. D. KIRKPATRICK, Editor

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JULY, 1935

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SOCIAL REFORM vs. CONSTITUTIONAL GOVERNMENT

MOTIVATING PRINCIPLES revealed in Washington during the past few weeks seem, in retrospect, vastly more important to American business than the particular issues that made them apparent. Social-reform legislation, proposed or enacted, for taxation, control of labor relations and regulation of public utilities will all vitally affect some segment of industry, but they dim to insignificance when one contemplates the full implication of all that is behind them. Instead of relief from regimentation and political domination, the Supreme Court decision seems to have been a signal for releasing a veritable flood of disciplinary and punitive measures.

Perhaps we are unduly disturbed by what is after all a mere play of politics. We sincerely hope so—despite the fact that it is not pleasant to contemplate an industrial future dependent upon the whims and personal prejudices of partisan politics. Rather, we have had reason to hope for the return of constitutional government free from domination by executive, legislative or judicial function. That can come about only as the public can be made to realize what these dictated measures and their motivating prejudices mean to our individual and industrial futures.

What are some of these prejudices and their apparent implications? First is the often-repeated view that "Bigness is Badness" and therefore must be destroyed. That philosophy we first saw in the bill to annihilate rather than regulate the holding companies and later in the share-the-wealth, soak-the-rich proposal as a basis for taxation. Second is the view that industry is not to be trusted and therefore must be put in a strait-jacket such as the new Wagner law on labor disputes. Capital and labor are blindly set apart in armed camps because of failure to appreciate the fact that they can and have and should work together in a common purpose. Third is the power-drunk idea that only through strong centralized federal control can government cope with present-day problems. The constitution must be "modernized" and in the meantime the distribution of patronage and relief funds serves to give unprecedented power for the control of legislation. And, since the mills of justice grind so exceedingly slow, there is a long lag between executive action and the final judicial confirmation or denial.

Why should such matters as these be discussed in *Chem. & Met.*? Chemical engineering has no place in it for partisan politics. That we grant, but when political developments threaten the whole future of successful management or professional participation in industry, it is time that chemical engineers and executives make themselves heard. Now as never before, there is a need for active, intelligent and aggressive challenging of dangerous trends in government. May we hope soon, however, for the day when the American public awakes to the fact that this continual baiting of industry is retarding recovery because it is stifling the only source of initiative, confidence and private enterprise that can bring about better times in this country.

From an EDITORIAL Viewpoint

"Retain a Consulting Engineer"

ONE FEATURE of the new F.H.A. program for modernization loans to industry, discussed on page 362 of this issue, should be of special interest to consulting chemists and engineers. Very often the outside viewpoint is the one to see first the opportunity where a little money invested in new equipment and technology would yield a quick and profitable return. From a professional standpoint there would be nothing unethical about pointing this out to a manufacturer and helping him to plan his modernization program. The Federal Housing Administration recognizes this in the following advice to would-be modernizers: "Sound engineering knowledge is not only desirable but necessary in planning for new factory and plant machinery and plant modernization. The fees of a consulting engineer are a permissible expense in any modernization program under insured credit. Start your plant modernization under the direction of a qualified engineer."

A Hazardous Type Of Decentralization

TWELVE fertilizer codes, one for each zone of the industry, are proposed under the new plan developed at the recent meeting of National Fertilizer Association. To an outsider this would seem the wrong kind of decentralization. It would be unfortunate if by this system of reorganization the industry is going to lose the momentum in cooperative trade practices which it gained during the reign of the late, but unlamented, Blue Eagle.

This is a day of decentralization in manufacturing. And in some types of industry this trend is very definitely justified on the grounds of economics. But it is also a day of cooperation in business matters. Our thinking must be national, even if our manufacturing and marketing is broken down into regional groups. Sniping across zone boundaries is so easy that the new N.F.A. program may prove altogether ineffective. It is to be hoped that it will work better than appears likely. If it does not, the industry can, and certainly should, go back to a nationally coordinated program.

That a national program is fully justified is clearly shown by the summary of the recent past presented by the officers of N.F.A. at the recent convention. There has been a gradual increase in tonnage, sales in 1934 being approximately 15 per cent over 1933, and estimates for 1935 indicate another increase of about 10 per cent. Despite highly competitive conditions, the elimination of below-cost operations enabled the industry to make a little profit during both the last two seasons. Furthermore, and contrary to much loose talk, the small companies of the industry gained business relatively faster than the large concerns. Thus, there has been a broader, more stable economic base placed under this fundamental chemical enterprise which so importantly serves agriculture.

Farm Chemurgic Formally Organized

CAPITALIZING on the novelty of the name, the sponsors of the Dearborn conference between agriculture, industry, and science have founded Farm Chemurgic Council. Despite controversial publicity this new association has a much broader purpose than mere support of alcohol for motor fuel. The purpose is broadly to sponsor any form of non-food utilization of agricultural raw materials.

Fundamentally this objective is sound. Economically and scientifically, all should work with diligence on every project that gives real promise of success. The new Council headed by a responsible, yet enthusiastic, group of men can stimulate much thought and perhaps real business interest in new and sound enterprises. To the extent that they do this, they will deserve, and promptly receive, support from every quarter. The chief danger is that excessive zeal may at times give the onlooker a distorted picture of early prospects, or make claims which, because extravagant or premature, cannot be borne out in experience. If the enthusiasm is appropriately tempered to avoid these evils, there is a fair chance that both industrial and social benefit will come from Farm Chemurgic Council.

Bring Forth The Achievements

AS SOME of you may have suspected, the longer editorials that have been appearing on the opposite page have something to do with the 1935 Award for Chemical Engineering Achievement. Each month we have attempted to focus interest on some field of activity that seemed most productive of the sort of group effort and achievement which the *Chem. & Met.* Award is intended to recognize. Obviously, in the months remaining before the next Chemical Exposition in December, there will scarcely be an opportunity to review all of the promising and significant chemical engineering developments that have occurred since 1933. But we might, with the benefit of your cooperation, prepare a much more comprehensive list of deserving achievements for review by the Committee on Award. What have you to suggest?

Cheap Acetic Acid Now Challenges Achievement

ONCE in an unguarded moment we hazarded the guess that if acetic acid could be made cheaply enough in this country it might prove almost as important to chemical industry as the fixation of atmospheric nitrogen. Were we talking through the editorial hat or just trying to start an argument? Perhaps both, but it is at least interesting to speculate on what might be done with this useful product if it could be made for, say, 2 cents a pound for the 100 per cent acid.

Take cellulose acetate, for example, and try to guess what 2-cent acetic might mean in the way of further progress. Would there be a greater swing to acetate rayon? Would the transparent film of acetate displace the one of viscose? Would acetate plastics forge ahead of nitrocellulose and other resins? Would safety film predominate—not only in home movies but in all professional, X-ray and studio films? Would safety glass with acetate sandwich be cheapened sufficiently to bring about its universal use in auto, bus, street-car, train and plane?

Before answering such questions, need we remind you that cellulose acetate is only one of a number of applications and that cheap acetic acid might conceivably upset several other competitive apple-carts in the textile, leather, rubber and solvents industries? However, all our speculation is idle unless we are actually making progress toward such a revolutionary objective. So let's review the situation and the trends, if any, toward very cheap acetic acid.

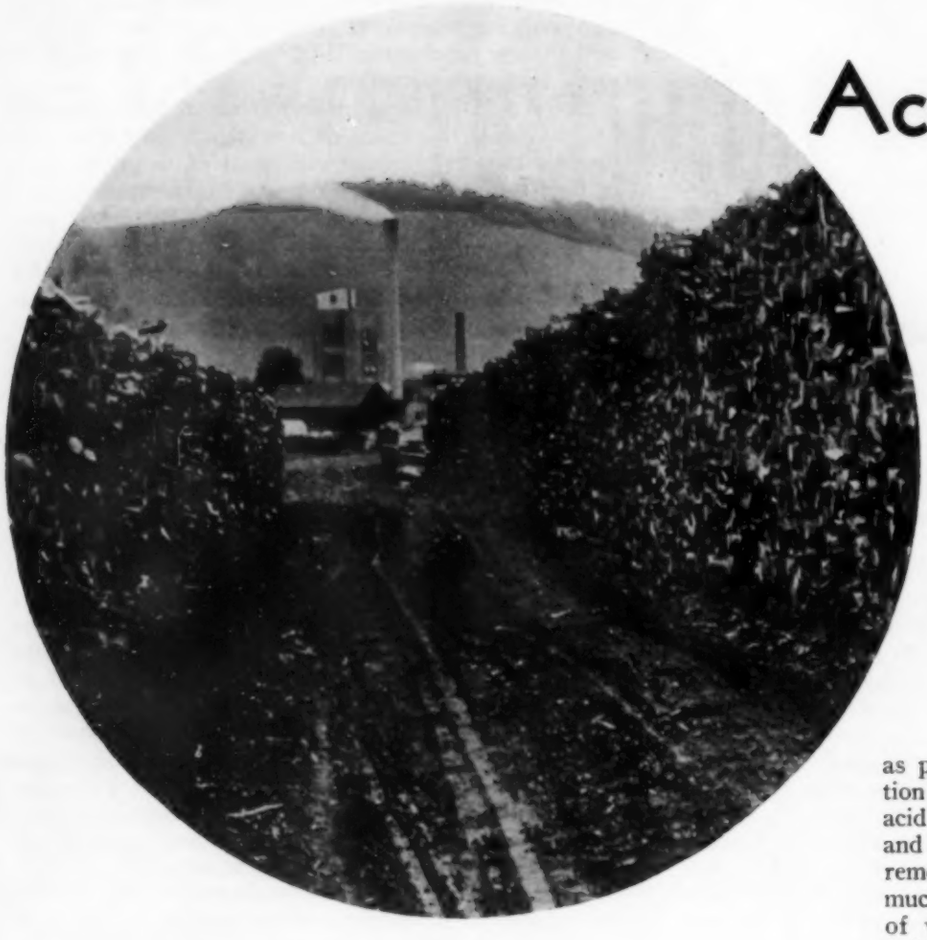
First recall that there are at least three broad groups of competing sources for this product, *viz.*, wood distillation, fermentation and synthesis. And in each of these groups there is further competition among the different processes. In hard-wood distillation, the first and oldest method is via calcium acetate which is now at death's grip with the newer, direct extraction processes. Among the latter we have the Suida introduced in this country by the Forest Products Chemical Co. of Memphis, the Brewster first used by the Quinn interests in New York State, and the Othmer process which is just now having its first large scale application in the plant of the Gray Chemical Co. in Pennsylvania. (In an unusual economico-technical article in this issue, Dr. Othmer cites some interesting cost figures that would seem to put his product into a lower cost class than has been reached hitherto in this industry. (This project he holds, might well be regarded only as a pilot plant pointing the way to what the wood distillation industry may yet accomplish through the application of sound chemical engineering technology.)

Acetic acid by fermentation from ethyl alcohol is a hardy pioneer that takes on new significance whenever there is talk of chemical utilization of distillery slops or farm wastes. The quick-vinegar fermentation plant of the U. S. Industrial Chemical Co. at Baltimore, produced the equivalent of 70,000 lb. of 100 per cent acid daily as long ago as 1918, and is still the world's largest producer from this source. Lower costs in fermentation would seem to depend largely on cheaper sources of raw materials. Perhaps the present interest in farm waste utilization for the production of motor fuels may also prove a stimulus toward cheaper acid by fermentation processes.

But it is in the field of organic synthesis that the most interesting battles are now taking place. Here at least two sources for acetylene are competing for the acetic acid cup while the rival alcohols, ethyl and methyl, are prospective starters once the race is on. Acetylene from calcium carbide has the longest and most successful record to its credit—having been developed at Shawinigan Falls, Quebec, almost 20 years ago and having operated in this country since 1927 in the plant of the Niacet Chemicals Corp. at Niagara Falls, N. Y. Acetylene may also be made quite handily from the unsaturated hydrocarbon gases of petroleum refining, and it is this source that is used by Jasco, the Standard Oil Co. of New Jersey subsidiary at Baton Rouge, La., in its fairly large-scale experimental plant. Cheap acetic acid from acetylene, in turn derived from ethyl alcohol, is satisfactorily produced in Great Britain and is said to be of prospective interest to the Dow Chemical Co. through its control of the Hale and Haldeman patents. Considerable time and money have been spent by the Chemical Engineering Division of the University of Illinois on the reaction between methanol and carbon monoxide which under high pressure and in the presence of certain catalysts yields acetic acid. The question here is likely to be one of capital investment.

So goes the inter-commodity, inter-process battles of competition in this interesting field. Perhaps we were merely provocative in suggesting that a factory cost of 2 cents a lb. was something to hope for as the eventual outcome. But in the past 20 years acetic acid has seen some drastic changes. From selling prices of 35 cents per pound in 1916 to 10-12 cents in 1920 and to 6-8 cents today is indeed a promising record. Meanwhile volume of production has steadily mounted until the 1934 output of primary acetic acid and its derivatives was perhaps 30 per cent above that of the preceding year—which was a record up to that time. The point is, of course, that the acetic acid industry has been making striking progress in both the economics and technology of its production. Who is to say that that progress is at an end? Certainly not the chemical engineer looking for further fields of development and achievement.

Acetic Acid



From wood and wood waste to acetic acid (refinery in background) to profit

DEMANDS for acetic acid as such were never better —yet millions of pounds of calcium acetate as "gray lime" pile to the rafters of wood distillers' storehouses. Over a baker's dozen of wood distillers have even sent calcium acetate through the furnace to produce acetone. Thus was the price of the calcium acetate so desperate that wood distillation had to compete with Weizmann's BY bacteria on the acetone front. Acetic acid in this form has sold at a depression low of 1.3-1.5c. per lb. And that is a depression indeed to an industry nurtured on wartime demands for acetic acid and acetone when in this country no BY bacteria had yet seen the inside of a test tube or been seen on a microscope slide.

Wood distillation, literally has paid to give away its acetic acid in an attempt to pull itself out of a depression by bootstraps worn out 15 years ago. Simultaneously the technology of synthesis in the hands of what is probably the largest single producer of the acetic radical turns acetone into acetic or acetic derivatives—at a profit. (The corollary is that if some fraction of the technical thought and skill spent on synthetic chemistry were spent on chemicals from natural sources, the latter industries and chemical products might well be in a better position.)

The answer, plain as Cyrano's nose, is direct acetic acid. And not 'round the cycle of 6 to 7 per cent acid as pyroligneous, lime and evaporation to remove the water, sulphuric acid and heat to remove the lime, and distillation and fractionation to remove some acetic as such, and much more as "improper fractions" of various dilutions. A short inquiry into the economics of acetic acid as related to wood distillation indicates the real fallacy in the traditional manufacture of calcium acetate.

The evaluation of the costs of calcium acetate production presents considerable difficulty because of the interrelation of the costs of producing alcohol, tar and charcoal simultaneously, as well as the lack of cost accounting in the industry. As there is a tremendous difference in cost of producing a gallon of pyroligneous acid leaving the retort condenser under the diverse conditions encountered in the many plants, this figure will be considered later.

Of more interest is the acid liquor after the value of the alcohol is subtracted; or the alcohol itself removed, as in the Chute still introduced a generation ago and standardized as a simple exhausting column in numerous Michigan plants these many years.

Again there is no stated value for this dilute acid, usually about one part acetic to 12 to 15 parts water. Wood cost plus operating charges less charcoal, alcohol and tar revenue would give the acetic value as a difference. Simpler, take the acid as is without giving it any values and see what it costs enroute to calcium acetate.

From actual cost figures, partly published and all compared with operations in various parts of the country by several chemical engineers in the industry, the following charges are itemized per cord of wood resulting in approximately 200 lb. of gray lime. Single-effect primary stills and open pans for final concentration are assumed as typical for most plants; and the cost of pumping cooling water is included in steam and power charge.

75	lb. of lime @ $0.48 per 100 lb.	$0.36
6,400	lb. of steam @ $0.30 per M	1.92
5	kw.-hr. electric power @ $0.01 per kw.-hr.	0.05
1.2	man hour labor including production, storage, baggage, shipping @ $0.40 per hr.	0.48
1.4	sacks for shipping @ $10.25 per C	0.14
	Processing costs per cord of producing calcium acetate from pyroligneous acid	$2.95

and a Profit from Wood Distillation

By D. F. OTHMER
Polytechnic Institute
Brooklyn, N. Y.

These figures are probably representative of an average set of conditions. Thus while steam @ 30c. per M is over twice the actual cost among some favored units burning their own natural gas, it is only two-thirds the cost at other units where coal is hauled from a great distance.

This is only the processing cost of the crude acetic to acetate with no consideration of cost of previous operations or raw material, depreciation, maintenance, indirect labor as chemical, or direct supervision, management, and so forth. Yet this cost is $2.95 per cord of wood (200 lb. calcium acetate) or $1.48 per 100 lb. of product. To this has to be added before sale (at present market of $2.10) an average of $0.35 freight and $0.06 brokerage, totaling $1.89.

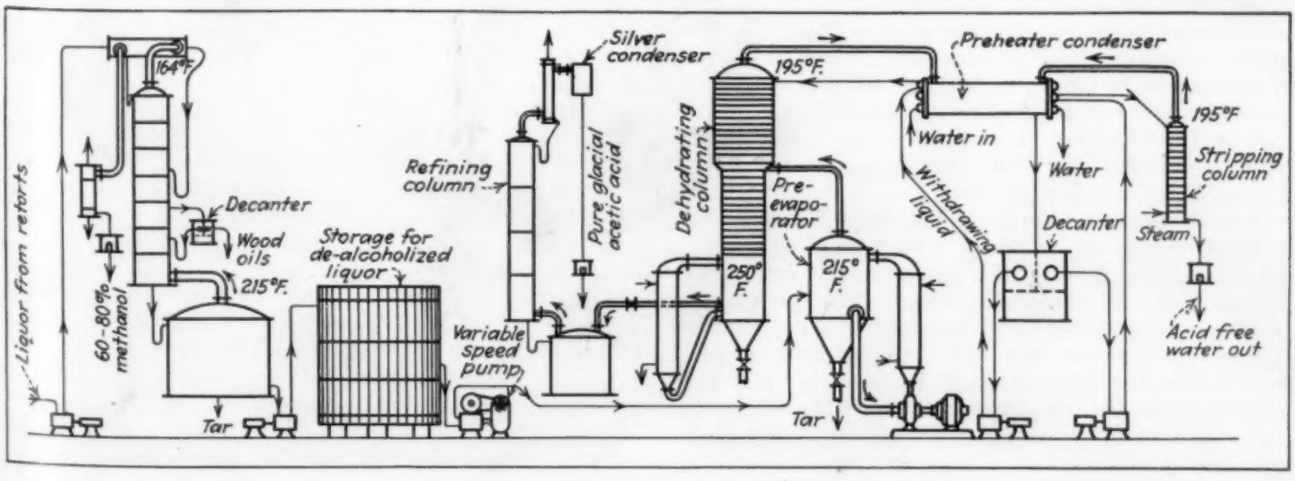
In one of the few plants where complete cost accounting for all the processes is used, pyroligneous acid, after tar and methanol removal, has been charged at slightly less than 1c. per lb. acid figured as 100 per cent acetic. On the basis of 130 lb. of acetic acid per cord, if this additional $1.25 per cord for material and carbonization costs were included, the figures would be $4.20 per cord before sale or $2.51 a 100 lb. after sale. In another large plant approximately $10 has been the total and rather high cost per cord of wood carbonized after deduction of a credit for the charcoal, representing cost of distillate leaving the retorts. Two-thirds of this has been apportioned to the calcium acetate following a custom long in use in many plants. If this is written down to about $8 which probably represents a more average producer, the total cost before sale for acetate, including depreciation, repairs, and all other charges would then approximate $5.30 per cord. This would be $3.06 per 100 lb. after sale at $2.10.

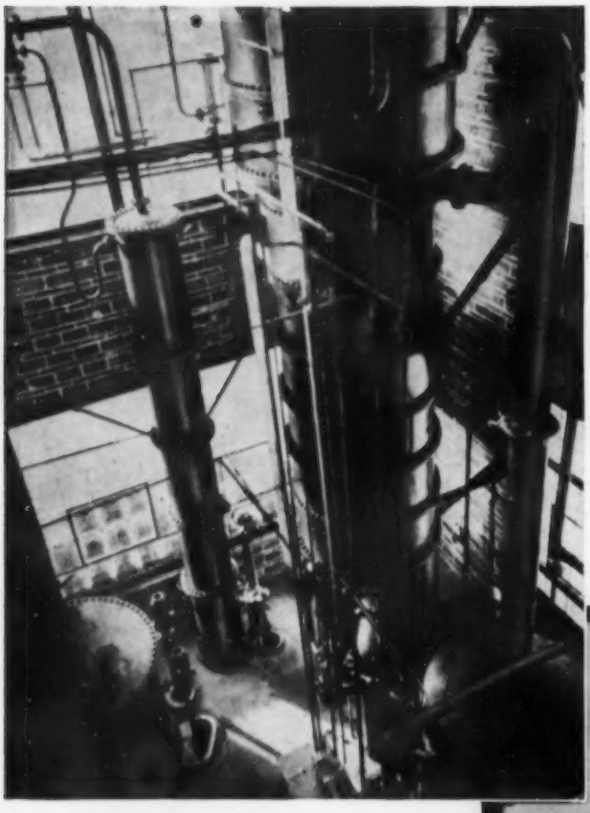
If these figures were directly comparable in any way, the difference between the $3.06 and the $2.51 or $0.55 would represent the overhead, maintenence, indirect labor and various capital charges against the lime acetate processing alone which are not included in the table above. While it is hard to say just how far these various figures can be used, there can be no doubt that these additional charges when evaluated in any way and added to the $1.89 per 100 lb. would bring the total processing cost for this step alone much above the selling price. (One major company after a complete survey decided as long ago as 1926 that it would be cheaper to dump the acid in the river, while this seems easy many conditions make it impracticable.)

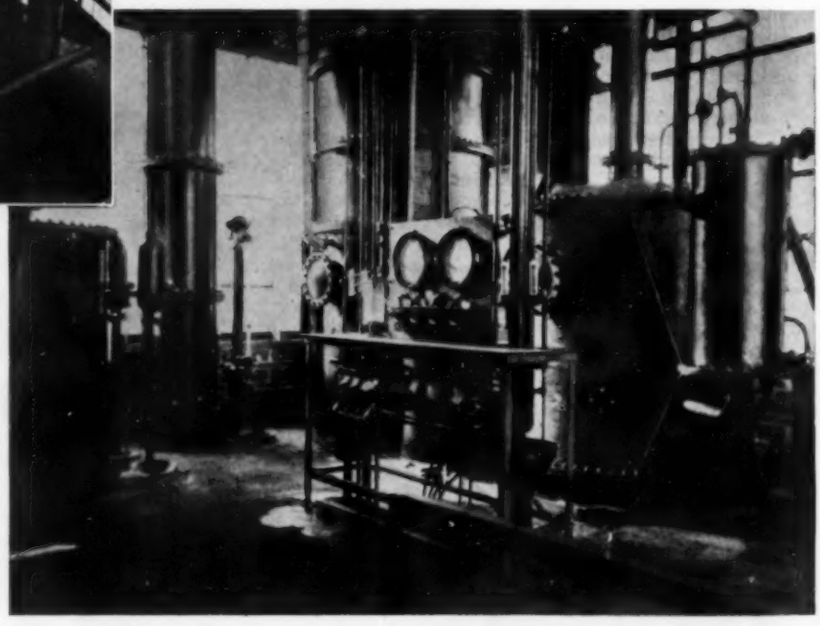
Keep track of that $2.95 a cord of processing cost ($4.20, at least, if acetate is to carry a share of the raw material and carbonizing costs) and consider that it represents the cost of converting into a compact but uneconomic and at present almost unsalable form some 130 lb. of acetic acid. If the advertised $2.10 a hundredweight were available promptly for all the acetate, and there were no tremendous stock overhanging the market, these figures would be still in the red. No one has looked for profit in gray lime manufacture these many years.

The general features of the economics of calcium acetate have been discussed since the industry's private depression broke with the advent of synthetic methanol and the flop of wood alcohol prices some years before

Flowsheet of the plant of Gray Chemical Co. at Roulette, Pa., producing acetic acid by extraction and azeotropic distillation







Above—Column well (between operating floor and condenser level), pre-evaporator lower right feeds vapors to entrainment separator upper right corner thence to column, refining column against window, decanter lower left

Right—Operating floor and table, all instruments, valves and controls centralized here; pre-evaporator on right, azeotropic column rear center, refining column against window, decanter and level controls far left

the general depression appeared. The relapse occasioned a little later by domestic production of synthetic acid should have called for the stimulant of cheaper processing to secure "direct" acetic acid.

No relief was obtained, and it is worthy of note that, self-evident as the symptoms seem since R. S. McBride's clinical diagnosis of the condition of the 49 United States plants in *Chem. & Met.* in 1932, only one unit has taken steps to remove the usual malady of "calcium acetatus." That step was taken in the latter part of 1934 by the late Monta Burt, then president of the Gray Chemical Co. of Roulette, Pa.

But he put in no hurry-call for help, because, as the unofficial leader of a score of similar small distillers not so well heeled, Burt felt his obligations to get a system applicable to the needs not only of his own plant, but also to those of other small independent wood distillers. These requirements were (1) Complete recovery of all acid as the 100 per cent or glacial grade so that every market would be open and freight on 10 to 30 per cent of water would be eliminated (the large and fastest growing market, cellulose acetate production, can use only this grade), (2) minimum equipment cost, (3) minimum operating cost, and (4) simplicity and dependability in operation.

The last item was—and is—most important and should be emphasized because, although most of the Pennsylvania wood distillers are proud of their chemical names and products, they are by intent, operation and psychology, lumber operators with a minimum of chemical skill and experience. No "high falutin" plant requiring careful nursing by "long beards," *i.e.*, technologists, could survive in the small scale units which are characteristic of this industry!

The tremendous complexity of processing and the high equipment cost of the several methods proposed for separating acetic acid and water seemed little in keeping with the informality and simplicity of the usual wood distilling plant. The technical and financial failures of various processes when applied to other and much larger plants were causes for concern. The high-pressure steam, and, therefore, new boilers which would be required for one system and the final acid strength of from 65 to 90 per cent, which was the highest grade usually produced directly and without additional expense for rectification, added to the riddle.

Monta Burt studied the situation carefully. Articles in *Chem. & Met.* (December, 1933, and February, 1934) promised a simple and economical solution. When demonstration equipment for the continuous production of a few pounds daily of anhydrous acid from pyroligneous was carried to his plant in two parcels stowed in a Pullman upper and set up in a few hours' time, his course was established. Several thousand dollars were contributed by neighboring plants through the Manufacturer's Charcoal Co. and a semi-works unit built and operated in the spring of 1934 to demonstrate to everyone's satisfaction the easy method selected.

The plant as finally installed to separate wood alcohol, tar, acetic acid and water is simple—so simple

that it seems to be less expensive in both equipment and operating costs than any of the other plants in this country or abroad. It was designed and fabricated to fit the needs of this process by the Vulcan Copper and Supply Co. of Cincinnati; and while many simplifications and economies have been worked out for future installations, it probably represents the only modern unit of any type or purpose in the entire Eastern wood distillation industry.

First, there is the demethanolizing column which takes the liquor direct from the storage tank into which the retort condensers discharge. This is a continuous unit with the cold feed passing through the dephlegmator—preheater for heat interchange and economy, thence to a point about two-thirds up the column. Below this feed inlet the plates are of perforated construction because of the necessity for cleaning of tar deposits. Each plate is a separate section with a manhole for cleaning purposes when necessary. The plates above the feed section are more closely spaced since they require no manholes and are fitted with bubble caps of a special design to prevent fouling.

While the column design is novel, this operation of demethanolizing has been practiced on the acid liquors for many years, with success even in standard type distilling columns. These, of course, are not as adaptable to the cleaning which is necessary when the tar tends to plug the unit.

At a mid-section a portion of the liquid on the plates is withdrawn and passed to an external decanter to remove the wood oils which steam distill and have a boiling point too high to allow them to go over the head and too low to go out of the bottom. Hence, they collect and must be removed from the middle. This decanter is the principle difference from the Chute system (U.S. P. 824,906—1906). It allows a higher-proof alcohol at the top and prevents the necessity of very frequent cleanings.

The alcohol discharges from the top 50 to 85 per cent strength, depending on the operation desired, and contains the acetone, methyl acetate, and other "heads" which give it its characteristic odor and solvent properties. The de-alcoholized liquor discharges from the base heater which is one of two old "primary" stills formerly used for the detarring distillation in the lime acetate process and converted to this use.

The solvent action of the tar and tar oils in the liquor prevents the frequent fouling of the de-alcoholizing column which has often been encountered in this operation; and only occasional cleanings are necessary.

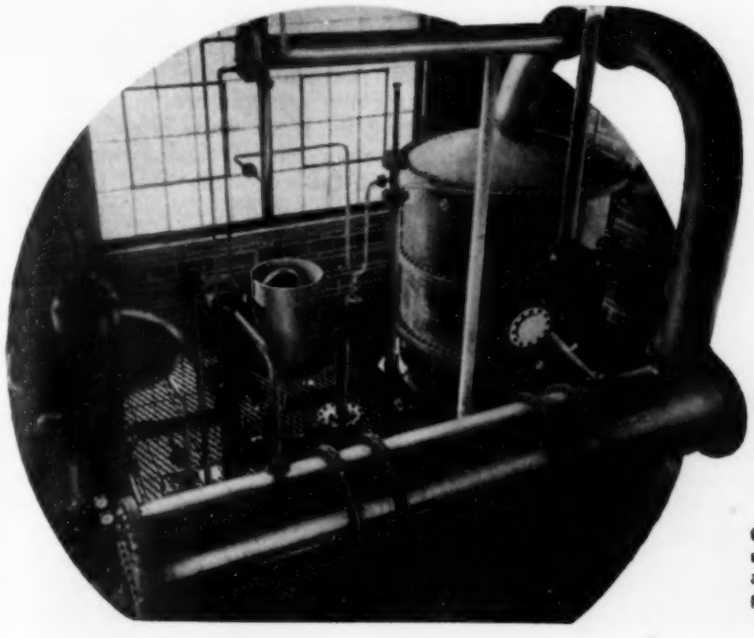
Underflowing from this base heater, the de-alcoholized liquor and tar, which is largely separated by decantation, passes to the storage tank in the acid house. Thence it is metered into the system by a variable speed proportioning pump, since any usual flow meter would clog with the omnipresent tar.

The pre-evaporator with external calandria and positive circulation by pump to prevent fouling of heating surface by tar deposition has a 6x6 ft. body which replaces three 12x10 ft. primary stills with ordinary coils. Unlike these predecessors for vaporizing the aqueous acid away from the tar, this unit keeps going without shutting down for cleaning or "tarring down." Tar settles and is withdrawn every hour from the conical bottom of this unit.

Vapors pass through an entrainment separator, thence to the expanding section between the upper larger and the lower smaller sections of the dehydrating column. The major part of the heat, and hence largest volume of vapors passes in the upper part, while the smaller lower section is supplied with a much smaller vapor volume from the base heater.

Since water cannot be removed by simply distilling it out, as is the usual practice for separating two liquids of different boiling points, it is "steam distilled" away from the acid. In ordinary steam distillation, water, as steam, is added to steam distill out an oily liquid which is insoluble in water and is recovered after condensation by decantation. In this case, the mountain is brought to Mohammed, rather than vice versa and an "oily liquid" is added to steam distill the water over the head of the column. After condensation in a single condenser the oily liquid, usually called a "withdrawing agent," is decanted away from the water and returned to the top of the column as reflux wash to keep down the acid concentration and to contact with and withdraw more water.

This azeotropic principle has been previously described in *Chem. & Met.* (Dec. 1933), and of the scores of withdrawing agents which have been developed, used, and patented by the author for this use, one has finally been selected within the last few months as preeminent in separating efficiency, steam economy and column capacity.



Condenser level, 7-pass condenser using three cooling media, top of azeotropic column right background, silver condenser center background

It reduces in this steam distillation the effective boiling point of water from the normal 212 deg. F. to 195 deg. F. which is the boiling point of the so-called azeotropic or constant boiling mixture. This lowering of the boiling point of water gives a large enough spread between it and the 244 deg. F. boiling point of acetic to allow a separation by rectification.

The azeotropic mixture contains approximately 28 per cent water by weight; but because of the high latent heat of water, 74 per cent of the latent heat coming over the head of the column is that of the water and only 26 per cent is due to the entrainer. Thus, since the withdrawing liquid is returned as reflux after decantation only one part in four of the heat is abstracted as reflux heat; or the reflux ratio, in the usual calculation, would be one part of reflux to three parts of product—which may be regarded as an inexpensive distilling operation. Since the vaporous heat in the water drawn off as product is supplied (along with a comparatively negligible amount of heat in the 6-8 per cent of acetic acid) by the pre-evaporator, it follows that the base heater of the column will have to supply only the latent heat of the entrainer in the azeotropic mixture (plus radiation and minor heating effects) and this is about one-third the amount supplied in the pre-evaporator.

By comparison with previous practice, the pre-evaporator which is about a tenth the capacity of the old primary stills accomplishes the same function of tar removal; but the heat expended is approximately three-quarters of the total amount used completely to dehydrate the acid while previously this same amount of heat was entirely wasted to cooling water and was the largest single cost in producing calcium acetate.

Here then is an operation which theoretically removes one pound of water by the expenditure of 1.33 lb. of steam. In practice with everything considered, the expenditure has been less than 1.5 lb. of steam per pound of water removed from the acetic acid. There is from 11 to 15 times as much water as acid in the pyroligneous at this point—the variation is due to moisture content of wood, method of firing, and whether or not pre-dryers are used. The heat consumption to remove all of the water is thus from a possible minimum of about 16.5 lb. of steam per pound of anhydrous acid produced to a possible maximum under the worst circumstances of 22.5 lb. steam per pound anhydrous acid with a fair average at about 20 lb. (A small additional amount is required for refining.)

The particular method of operation and this withdrawing agent requires only 70 per cent as much steam and has a through-put with a given unit 50 per cent greater than the first used agent which was the equivalent of the best other liquid used commercially.

Because of the separating efficiency of the withdrawing agent selected, a column of only 36 plates is used. A larger number of plates is required for the better known and commonplace distillation of industrial alcohol from distiller's beer containing about the same amount of water. Unlike the usual alcohol distillation, and all other acetic dehydration processes, all of the water is removed in this one operation: it flows from the top of the column containing only 0.01 per cent acetic acid, while the latter flows from the bottom containing from 0.1 to 0.5 per cent water. The water run off is called "sweet water," being well named in that it has only one part in ten-thousand of acid.

A Good Rectifying Operation

Because of the closeness of the boiling points of these two liquids, and the fact that for 50 years it was thought impossible to separate them by distillation, this is a good rectifying operation. Judged by any standards it is a good separation for a 36-plate column when it is considered that the "reflux heat" is only approximately one-third the "product heat." It seems a very neat operation compared with the falderol of "indirect" acetic and the multiplicity of operations and units in other "direct" acid plants.

The sweet water saturated with the withdrawing liquid discharges from the decanter, and while this solubility is relatively low the water must be continually stripped in a simple exhausting column to retain this small amount in the system. This column operates with the liquid feed on the top plate and live steam at the bottom. Spent water discharges at the base and the same azeotropic mixture is formed at the top of the column. The same scheme of condensation and decantation is used—but with reverse English this time—to discard the withdrawing liquid. The vapors are, therefore, passed to the main condenser and the operation continues with a small amount of water continually withdrawing and discharging the dissolved "withdrawing" agent in a literal steam distillation analogous to, but on a tremendously smaller scale than the operation in the main column.

Of particular interest from the standpoint of equipment design is the condenser unit for the dehydrating column which handles the vaporous mixture of water and withdrawing liquid, and its relation to the several parts.

In order to keep the over-all height of the building structure within limits: (1) of economy of structure, (2) of operating accessibility so that only one man would be required for complete operation of the plant, the single condenser was built along the side rather than at a higher level than the column. The decanter underneath the condenser is placed on the operating level on which the base heater under the column also stands.

The two immiscible layers from the decanter discharge to pump suctions below through sight glasses and float control tanks, the function of which is in each case the maintenance of a liquid seal on the pump suction. Thus, air and its corrosive influence is kept from entering into the system.

Operation of Condensers

Both liquids are now en route to the top plates of their respective columns—the withdrawing liquid going back to the main column to pick up more water, and the sweet water to be stripped of the trace of withdrawing liquid. The temperatures at the tops of both columns are approximately the same, since both are at the azeotropic or constant boiling point. In order to economize heat, the two liquid streams pass through two passes each of the tubes of the main condenser, and are thus heated to within a few degrees of the temperature at each column head. The cooling water has three passes which bring the total number within this condenser shell to seven, divided between three cooling media—cold water, water saturated with withdrawing liquid, and withdrawing liquid.

Although anhydrous, the acid contains several per cent of impurities when it leaves the base heater of the dehydrating column. These impurities include the last traces of tar, but are mainly higher boiling homologues of acetic—propionic and butyric. The additional value of these over acetic almost pays for the standard batch rectification, in the presence of an oxidizing agent, separating C.P. water white glacial acid from these homologues which may then be worked up for their special uses.

This final trace of tar is wasted. Tar has come out from previous steps in the process: (1) in the storage tank from the retorts, (2) at the base of the alcohol

column, (3) as tar oils in the alcohol column decanter, (4) in the storage tank from the alcohol column and (5) from the pre-evaporator. Tar and tar oil refining, separation and development work on new tar products from the material from these several parts are well underway by Arthur Stevens and his associates in the related Hardwood Chemical Co. next door. Surprisingly, these materials, objectionable as they are to process equipment, are separated into many materials, which while not as commercially important as coal tar products, have various uses in many fields. That which has no other use is burned under the boilers, or reduced to pitch by distilling off volatile matter.

The building structure to accommodate this direct acid process was unnecessary for the needs of the Gray Chemical Co. alone, but in line with Burt's policy of cooperation it was constructed, the refining column designed, and storage capacity planned so that in the event neighboring wood distillers installed units to produce direct acid, such acid could be refined in this building as a "community" enterprise. With a minimum of changes, the acid from as much as 400 cords can be continuously refined here, with a consequent saving in equipment and operations to the neighboring plants.

Because of the large increase in acid dehydration capacity due to the substitution of the present superior withdrawing agent for the one first used and for which the equipment was designed, the unit has a capacity for acid from 90 cords per day and it is expected to install additional carbonizing equipment to increase the present 60-cord capacity.

Responsibility for the regular operation of this process has been placed in the hands of men not trained as either chemists or chemical engineers, but who have had the characteristic practicality of the industry. While they experienced the usual difficulties encountered in swinging any new plant into operation, the principal delays were occasioned by shutdowns due to the modernization program being carried on in the other departments of the plant. The requisite simplicity for a successful unit in this industry has been well demonstrated; and will be even more apparent in future installations, due to the elimination of certain items found non-essential in this.

Here then is a set-up which turns out some 130 lb.—usually more—of acetic per cord of wood carbonized at a value of at least 5c. per lb. at the plant; a conservative figure is a revenue of $6.50 per cord.

Question:—What will it cost to install another plant, making use of the economies learned here? Answer:—from $500 to $900 per cord daily capacity depending on the conditions of existing contributory equipment, size, tankage, refinery requirements, and so forth. For those few plants now making acetic by conversion of calcium acetate with sulphuric acid the refining equipment and tankage is in; and the cost will be considerably lower, as it also will be for those neighboring plants in Roulette which may ship acid in for refining rather than installing refining equipment.

Question: What does it cost to turn out 130 lb. of water white glacial acid from the dealcoholized pyroligneous from a cord of wood in one column and the refining column from a plant of say 90 cords capacity? Answer:—(Average conditions for the industry assumed, present cost at the Gray Co. are much lower.)

25 lb. steam of 50-80 lb. pressure per lb. of acid = 3250 lb. cord @ $0.30 per M	$0.975
½ man hour labor @ $0.40 per hr.	0.13
Chemical laboratory and supervision (¼ time of each of two men)	0.04
16 kw.-hr. electric power (including water pumping) @ $0.01 per kw.-hr.	0.16
½ lb. loss of withdrawing agent @ $0.10 per lb.	0.05
2 lb. sodium bichromate @ $0.06 per lb.	0.12
Direct production cost for 130 lb. acetic from 1 cord wood	$1.475
Direct production cost for 1 lb. acetic	$0.0113

Now compare this processing cost with the $2.95 per cord processing cost of calcium acetate. It is almost exactly half as much. The difference—$1.48—times 300 operating days per year shows a per cord capacity savings of $445 per year by making a material which the market wants as compared to making a material which the market does not want.

But that $445 a year savings will easily build a direct acid plant in two years time. After two years it is paid for and processing profits accrue because of the comparative economy of manufacture of acid over manufacture of acetate.

There may be an objection to this comparison on the basis that capital charges, depreciation, repairs, and so forth, are not included in the two items and that the calcium acetate process is working with existing equipment and the direct acetic process involves fresh expenditures and greater depreciation.

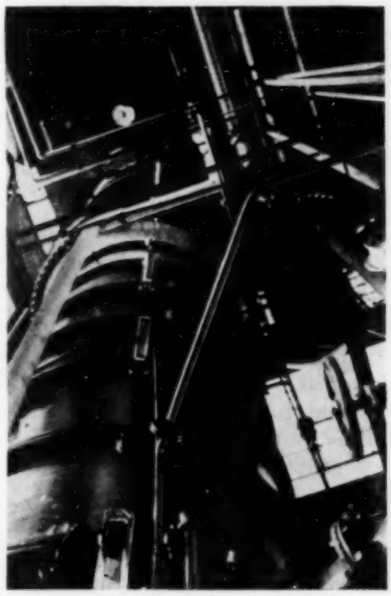
To the $1.475 per cord dehydrating and refining cost should therefore be added $1.25 as the value of the crude acid in the pyroligneous and $.74 to cover depreciation, amortization, repairs, insurance and related expenses. (This $.74 is obtained by taking 25 per cent of an estimated $80,000 plant cost and dividing it among the 27,000 cords of wood carbonized in a 300 day year.) The total is now $3.47 per cord which has to be compared with the $5.30 above estimated for the comparable costs on acetate production. This difference—$1.83—is even larger than before and indicates that the determination of an absolute value is quite difficult but that the figures are in line relatively.

As to receipts for the acids:—solid vs. liquid. Suppose first that the solid—calcium acetate—could be sold (just a supposition for accounting purposes as wood distillers have found these last years). At the advertised price of $2.10 per 100 lb. (recently up from $2.00) the revenue per cord would be $4.20, compared with $6.50 per cord for the 130 lb. acid, a difference of $2.30 per cord. Any selling price down from the $2.10 through the acetone level of $1.00-$1.25 and on down to absolute zero when piled indefinitely in the warehouse would represent a very much better approach.

Let it ride, however, as if the acetate was sold and add the $2.30 difference in revenue to the $1.48 difference in processing costs to give $3.78 a cord. About eight months would pay for the plant on this basis.

When these figures are multiplied by the cordage per day, it will be seen that the wood distillation industry is still a potential factor in chemical production, and when it awakes to these possibilities and obtains the necessary credit for plant construction it might well return to its position of a few years ago as the principal source of the most important organic acid.

A worm's eye view of azeotropic dehydrating column, to condenser level above



NEW MONEY For Plant Modernization

AN EDITORIAL

EVERY plant manager, every chemical engineer worthy of his salt, has up his sleeve some pet projects for improving the processes and products for which he is responsible. All these have in common the desire to make more money. But just as it usually takes money to make money, many worthy projects have had to stay in the laboratory or on the drafting board until management decided to make the necessary expenditures. That decision depended, first, on the prospects of selling the product at a profit and, second, on the availability of the money to do the job.

Both of these factors have changed sufficiently in recent months to warrant the reappraisal of all modernization projects, and, if the program is sound and the profit is there, action should be forthcoming. That business is better in most lines of the industry is fairly evident from corporation earnings and other statistics. But, more important, is that money—new money—is now available under terms and conditions never before existing in this country.

On May 28, 1935 Congress amended the National Housing Act so as to permit the Federal Housing Administration to insure individual loans up to $50,000 for the purpose of: "(1) Repair, alteration or improvement of real property, already improved by, or to be converted into . . . manufacturing or industrial plants or (2) the purchase and installation in connection with the foregoing types of property of such equipment and machinery, with or without any structural changes in the buildings, as are peculiarly adapted to the business connected therein or necessary to the operations thereof." Our quotation is from Regulation No. 24 of Title I of the revised act.

What does all this mean? If you are familiar with the workings of F.H.A. and what it has already accomplished in its home modernization program where loans were limited to $2,000, you will check us on the following facts:

1. This is *not* government money. It comes directly from your local bank or lending institution which is protected against loss by F.H.A. insurance to the extent of 20 per cent of the total loans so made.

2. There is a minimum of red tape. You merely apply to the bank which displays the "house in a circle" sign and make your application just as you would for any other loan. The terms are up to you and the bank. In many cases they will be simply character loans, based on your local banker's knowledge of you and your company. Or the bank may require collateral or even a chattel mortgage on equipment—but the point is that F.H.A. is doing all it can to liberalize and simplify the process.

3. This is long-term money—up to five years if desired. The only requirement of the basic act is that the loans must be payable in monthly installments and carry an interest charge not exceeding the equivalent of $5 discount per $100 face amount of a one-year note payable in monthly installments.*

Other features of the new FHA program worth recalling are: (1) No down payment is required; (2) Any type of production machinery or process equipment, conveyors, control apparatus, etc., may be purchased except certain mobile equipment and portable tools; (3) While loans are limited to $50,000 maximum, this applies only to the single plant. You may borrow on a dozen pieces of property if you have that many.

Direct loans, mostly in larger amounts, are also being made to industry by the Reconstruction Finance Corporation and the Federal Reserve Banks. The former, of course, is government money which was first made available in 1933 primarily to maintain and increase employment in companies that had been refused help from their local banks. Such loans usually involve company reorganization, scaling down of debts, and other drastic measures that were necessary to pull some sorely tried industries through the crises of 1933-34. The rates for such loans were set at 5 per cent simple interest. They can run until 1945.

More recently, through Section 13b of the Federal Reserve Act, member banks were authorized to make direct loans to industry for *working capital*. In purpose, this contrasts with the fixed capital loans from R.F.C. and the modernization or equipment loans of F.H.A. Like the latter, however, this is not government money but comes directly from your local Federal Reserve Bank or other approved financial institution. What the government has done here is merely to step into the bank and assure it of full liquidity by promising to insure the loan up to 80 per cent or to take it over at any time without recourse. Through this discounting procedure, long-term (five years) industrial loans, which most bankers have been trained to avoid, now become just as negotiable as commercial loans or other short-term paper. The loans bear interest at 4½-6 per cent, depending on the going rates in the different Reserve districts.

*While this actually amounts to 9.716 per cent simple interest, it is at least 40 to 50 per cent less than has been charged for similar loans prior to the F.H.A. insurance plan. For practically all types of self-liquidating modernization loans, this is said to be a satisfactorily low rate for such borrowing. However, you can and must check this cost of money against the savings to result from the purchase of the new equipment. You may be surprised to find how much badly needed equipment there is that will pay for itself several times over in the period covered by such a loan.—EDITOR.

Recent Developments in Manufacturing And Using Refractories

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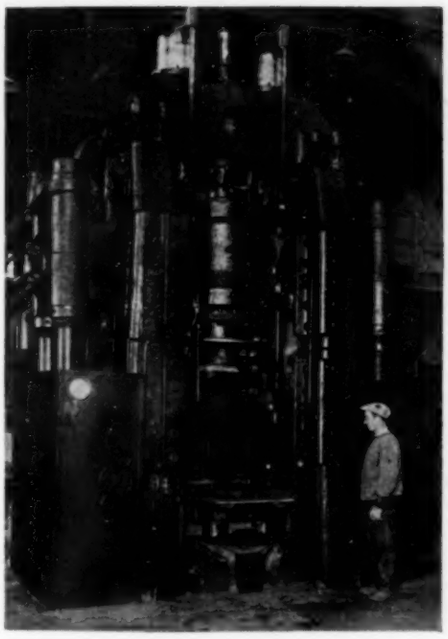


Fig. 1—10,000-lb. hydraulic press for molding Ritex unburned refractories

INNOVATIONS and improvements in refractories have been coming about in recent years, not because of new or expanding markets, as in the case of some of the newer alloys, but because the industry has found a definite trend toward a narrowing and more critical market for its products. Manufacturers, perforce, have had to operate more efficiently and toward a greater diversification of products. The industry has had to discover new ways of processing old materials, and of using totally new materials. It has made great strides in developing the latent properties of well-known materials and in producing products better suited technically to specific purposes.

The object of this paper is, accordingly, to point out the trends, to discuss the refractories available as the result of more scientific processing, and some of the applications of these newer products. If emphasis at times seems to be overdrawn on products or processes which at present are costly or do not represent the bulk of the tonnage of the industry, this is done purposely to record some thought-provoking changes which have taken place.

Trends in Processing

In general, the conventional manufacture of refractories has always been effected in five unit operations including grinding and screening; mixing; pressing or molding; drying; and burning. A great deal of practical knowledge and skill has been developed in the course of time regarding these unit operations. Gradually there has developed a realization of the value of determining in advance the definite guiding principles which enhance the unique properties that fit refractories for their special field of engineering materials. The principle which has resulted in the application of most of the more novel departures in manufacturing is the recognition of high bulk density, in any given group of refractory materials, as the most important single property which may be controlled in manufacture. It is this property that affects the greatest number of other important properties in service, such as strength, volume stability, slag and spalling resistance and heat capacity.

Grinding—The first point of approach to increased density obviously is the size of the grains constituting the batch. A number of refractories are now available in which high density is achieved by carefully screening out grains falling within certain size bands and recombining them in definite proportions. It has been found by experimentation that the densest mixtures closely approach binary systems of rather coarse and fine grains, in which the proportion of coarse to fine particles is about 55:45, and the percentage of intermediate particles is maintained at a minimum. The application of this principle is, of course, modified by a number of factors. It may be used most successfully on highly crystalline materials which do not compact readily under pressure; conversely it is of least value in brick mixes of inherently high plasticity.

Mixing—The function of this unit operation at one time was conceived to be mostly the homogeneous distribution of the various clays or other minerals used in a batch. Its true function is now recognized to be the distribution of the plastic material so as to coat thoroughly the non-plastic constituents, thus providing a lubricant during the subsequent molding operation and permitting the bonding of a mass with minimum voids. Improvements in mixing have been needed where the percentage of plastic material is low, as in the dry-press method and have been effected by departing from the older style of wet pan, a type of edge-runner mill, to the use of pans of the Simpson type.

Molding—The original conception of molding was merely the shaping of the ware. Accordingly, hand-molded batches were generally designed with a high proportion of plastic material and moisture. Hand molding persisted because it was adapted to small production and the manufacture of odd shapes. With the necessity for faster production of uniform standard sizes, the stiff-mud process developed in which a column of clay is continuously extruded through a die. However, the presence of lamination planes in the clay column has always been a major weakness. The continual call for brick of greater density, strength, volume, stability and uniformity eventually resulted in the dry-press method of molding with mechanically operated presses. This process is particularly suited for batches of mostly

Condensed from a paper presented by the author under the title of "New Developments and Trends in Refractory Processes and Materials" before the Wilmington meeting of the American Institute of Chemical Engineers, May 13-15, 1935.

non-plastic material. The effect of the magnitude of pressure employed in the dry-press method, however, has been so little appreciated that it has been only recently that the pressures in use have been determined with certainty.

An obvious method of increasing density, although attended by many practical difficulties, was to increase the molding pressure. This did not follow until one manufacturer had the courage to install a specially constructed hydraulic press, for regular brick production, capable of pressing at 10,000 lb. per square inch. This press (see Fig. 1) stepped up the pressure five to ten times over that attained on the usual mechanical press. There should be mentioned, also, the systematic study at Ohio State University Engineering Experiment Station (see the Station's Bulletins Nos. 56, 74 and 82) of methods to overcome the numerous practical difficulties with super-pressures.

Compression of the air entrapped in the voids of dry-press brick during pressing, with subsequent expansion upon sudden release of the pressure, results in a very undesirable type of lamination or pressure crack. In order to take advantage of the high density possible with high pressure, various means of de-airing brick during pressing were suggested in the above studies and now are being rapidly extended. The de-airing of dry-press brick may be accomplished in one of four ways, each with certain technical and economical advantages.

Slowing down the rate of pressure transmission and pressure release is effective since the air compressed within the voids can slowly seep out through the sides of the brick and mold box.

Double-pressing is another scheme which has been tried. The method consists in applying a very high pressure, not lower than 5,000 lb. per square inch, sufficient to allow the brick to crack. The brick are then repressed to heal the lamination planes.

De-airing by the use of a gas is also applicable. A gas such as butane is used to flood the mold box, displacing the air. With the application of pressure from the press ram on the mix, the gas either is adsorbed by the clay or condensed, and the mix then flows together to a well knit mass. Certain hazards in connection with the use of such a flammable gas have, so far, delayed the extension of this process.

Use of a vacuum, either through vents in the sides of the mold box, or through perforated or porous plates such as Aloxite, at the top and bottom of the mold box, is the method which holds most promise for dry-press brick.

Successful de-airing of stiff-mud brick by vacuum has been extended rapidly since 1932 in the industry and the number of installations is more general than for the de-airing of dry-press brick. In the stiff-mud de-airing process the shredded clay is fed from a pug mill into a chamber maintained under a vacuum of about 25 in. of mercury and then extruded as a continuous column by an auger through the die which forms the ware. Improved density and nearly complete elimination of the lamination planes typical of products made by this molding process are accompanied by a very high increase in strength.

The molding of large special shapes, which do not adapt themselves to machine molding, has been improved by borrowing some of the advantages of the other processes, particularly by tamping with pneumatic tools to attain very high density.

Drying—Drying is used to remove the moisture which was added preparatory to molding to develop plasticity. This added water, when subsequently eliminated, not only leaves voids which contribute to low density but causes high shrinkages and internal strains in proportion to the quantity of moisture present. Accordingly, use of the minimum feasible quantity of water is desirable. The so called dry-press process, involving the use of only 5-8 per cent of moisture, as compared with 10-15 per cent in the stiff-mud method, has been extended gradually to the manufacture of all types of refractory materials.

Elimination of such a large part of the moisture in dry-press batches has progressed to the point where dryers are omitted in some tunnel-kiln plants. The little drying that is necessary is accomplished during the heating up stage of the burning cycle.

The plasticity necessary for batches composed of 90-95 per cent grog has been successfully developed with very little moisture by the addition of an electrolyte to promote the colloidal character of the small amount of bond clay used. By thus maintaining the moisture at a low figure, the dried size is practically the molded size and nearly all strains attendant upon drying are eliminated.

Burning—Burning, or firing, as conducted in the typical round, down-draft periodic or continuous tunnel kilns of the industry has two important functions. One is to develop a permanent bond in the shaped ware, by partial vitrification of the mix, and the other is to develop temperature-stable mineral forms of the starting material, in anticipation of future service. The changes taking place in the firing of clay ware involve, first, removal of water of hydration, dissociation of carbonates and oxidation of sulphur and iron compounds. Then dissociation of the kaolinite mineral of the clay follows, to form the mineral mullite (the high temperature stable form of aluminum silicate), silica is liberated as cristobalite and a siliceous glass forms to act as the vitrifying or bonding agents. These chemical and mineralogical changes are accompanied by volume shrinkages as high as 30 per cent. Severe strains are set up as evidenced by cracking, warping and kiln marking due to settling or yielding of the highly heated plastic masses.

Rather than delay the entire development of the temperature stable form of the minerals in most refractory materials until the final firing stage, it is now recognized that it is better to start off with material as nearly prestabilized as possible and reserve as the chief function of the firing treatment the maturing of the bond—when this cannot be effected by other means. Thus are eliminated the strains accompanying the mineral changes described, and the original advantage of tight interfitting of sized grains, to set up high density, is maintained.

This trend to prestabilization of the grog, by the development of high crystallinity, is well advanced. In the aluminum silicate group, including fireclays, kaolins, some diaspore clays and the sillimanite minerals, mullitization or the development of the mineral mullite, $3Al_2O_3 \cdot 2SiO_2$, is the goal. Under ideal conditions, this mineral does not melt until a temperature of 1,810 deg. C. is reached, tending to develop crystals of long needlelike habit, tightly matted or meshed together. Calcined clays have always been part of the batch in making many fireclay refractories, but the temperature of calcining has frequently been lower than the temperature of firing the brick. Many of the clay refractories intended for high-heat and super-duty service now contain clays in which the precalcining temperature has been stepped up. A well known brand of kaolin refractory, in which mullitization is well advanced, is made of kaolin precalcined above 1,650 deg. C.

The so-called dead-burned magnesite used in making magnesite refractories has always been calcined in rotary kilns to temperatures of about 1,550 deg. C., of necessity, to get rid of the CO_2 constituting about 50 per cent by weight of the original mineral and to crystallize the MgO to periclase, iron oxide being used as a mineralizer. With a certain demand for low-iron magnesite brick, elimination of the mineralizer has necessitated even higher temperatures to stabilize the MgO. One manufacturer of chrome refractories has resorted to precalcination of his chrome ore at very high temperatures to effect a certain degree of grain growth which otherwise would take place later.

Actually, by the use of materials sufficiently prestabilized and properly sized and pressed, there are commercial refractories now on the market in which the burning operation is entirely eliminated, because the two functions of this operation have been effected by other treatment.

Attainment of high crystallinity has reached its ultimate commercial development in two super-heating processes, of quite different character. The one being used in this country depends upon crystallization from a completely liquid phase. The other, in Germany, is conducted almost entirely as a solid-phase reaction. Both processes promote such a high degree of grain growth that practically zero porosity results in the finished product.

Fig. 2—Electro-casting refractories in the Corhart plant

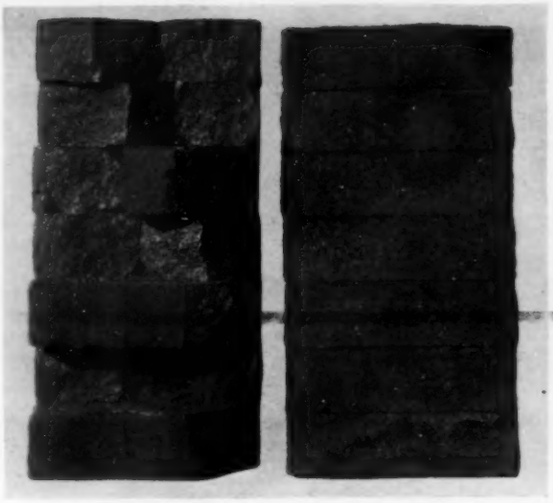


Fig. 3—Comparative resistance to spalling of Ritex and burned chrome brick

The German method has been applied successfully to the manufacture of small special refractories using a chemically pure material such as Al_2O_3 and employing a temperature of about 1,800 deg. C. This is nearly 300 deg. C. higher than that usually maintained in the hottest kilns, such as those burning silica brick. The products, known as Sinterkorund, are so dense and well crystallized that sections about $\frac{1}{8}$ in. thick are translucent.

The other method, better known in America, as used by the Corhart Refractories Co., is a radical departure from the established unit operations of the industry. The flow sheet of the process of this company could very easily be that of a steel foundry. The clays and ores used are merely mixed in the proportions to yield a mineral of a definite type (mullite at present), melted in an electric furnace of the Heroult type and poured into molds of the desired shape, as shown in Fig. 2. An operating temperature of 1,900 deg. C. is required completely to liquefy the charge. The method is also in use in Europe for producing refractories of a different type mineral than that of the Corhart company.

New Refractories

In spite of predictions to the contrary there are now available a number of new and unique refractories, largely as the result of new processing principles.

Super-Duty Fireclay Brick—This product is at present the most advanced development of strictly fireclay brick. It is characterized by high density and volume stability, which contribute to increased slag and spalling resistance. The latter property rarely exceeds 1 per cent loss in the A.S.T.M. panel spalling test (A.S.T.M. Proc., Vol. 34, part I, 796–803). The linear shrinkage after reheating for 5 hours at 1,600 deg. C. does not exceed 0.5 per cent. The development of this product was made possible because of the finding of special flint clays in which incipient vitrification develops only at high temperatures, and through improved manufacturing methods.

Refractories From Crystalline Aluminum Silicates—At best, the fireclay refractories are at a disadvantage which they will never be able entirely to overcome. A consideration of the phase equilibrium diagram of the binary system SiO_2—Al_2O_3 shows that the best fireclays containing about 42½ per cent alumina, when maintained at a temperature of 1,600 deg. C., which is not at all unusual as furnaces are pushed nowadays, are nearly 45 per cent liquid and 55 per cent crystalline mullite. Fortunately, this liquid is quite viscous and the refractories do not actually flow out of the furnace. It is easy, however, to appreciate why such a mass is not suitable to carry the high static loads which are encountered in furnace roofs. The logical trend in the search for better aluminum silicate refractories has been for a mineral which can readily be converted to nearly 100 per cent crystalline mullite. The natural highly crystallized members of the sillimanite group of minerals make the closest approach to this ideal situation.

Accordingly, refractories made from members of this group such as cyanite, sillimanite, andalusite and dumortierite, continue to appear in increasing tonnages, as available supplies are extended.

Attempts have been made sporadically to use the vast deposits of cyanite located in several of the south Appalachian states. Concentration is necessary, however, which not only adds greatly to the cost but breaks down the grains to sizes not entirely satisfactory for refractories. Real impetus to the manufacture of cyanite refractories is due to the availability of a special Indian cyanite occurring as very dense, hard, massive boulders which can be ground to any desired grain size.

Olivine—In the last year the mineral olivine has been exploited as a refractory. Natural olivine is a well crystallized member of the system MgO–FeO–SiO_2 consisting mineralogically of a solid solution of the orthosilicates, forsterite ($2\,MgO \cdot SiO_2$) and fayalite ($2\,FeO \cdot SiO_2$), the former predominating. The end members have melting points of 1,890 deg. C. and 1,205 deg. C., respectively. Dead-burned magnesite is generally added in making brick with the purpose of converting such accessory impurities as serpentine and talc to forsterite, which is the most stable high temperature magnesium silicate known.

Electro-Cast Group—This group, as pointed out before, includes Corhart's cast mullite. In Europe, an electro-cast chrome spinel called Siemensit has been developed. It is made from chromite, magnesite and bauxite and yields a composition of 20–40 Cr_2O_3, 25–45 Al_2O_3 and 18–30 MgO. Like bonded chrome brick, Siemensit refractories are neutral with respect to resistance to acid and basic slags. Lately a magnesite refractory to which about 5 per cent of barium oxide has been added, to enable the melt to be cast at a convenient temperature, has been produced in small quantity in this country. Thus to date we have electro-cast all our important commercial materials, except silica. Its extremely high viscosity has made it unattractive in this respect.

Ritex Process for Unburned Refractories—The production of refractories without burning, equally as good as fired ones, has always fascinated the refractories producer, because he not only could thereby eliminate a costly item from his balance sheet, but also reduce the time to get his product through the plant from 5 or 6 weeks to as many days. Further, the enormous inventories of finished products, which all refractories manufacturers carry in order to make quick deliveries, could be reduced. Practically all of these advantages would be shared by the consumer as well, so that the final development of unburned refractories in commercial quantities and standard sizes deserves special mention.

Earlier attempts by some manufacturers to develop unburned brick, particularly magnesite, have generally

resulted in chemically (organic) bonded mixtures, which were strong on drying and sintered fairly well under the heat of the furnace when used. However, two outstanding technical defects usually developed, namely, sintering was accompanied by shrinkage and the sintering was limited to the hot face of the refractory. The parts of the brick at intermediate temperatures lacked strength after the chemical bond was burned out.

Lack of bond and volume stability have been overcome in the refractories recently developed under the Ritex process of the General Refractories Co. In this three distinct improvements in the unit operations are involved. First, the interfitting of the grains has been developed to a maximum by using only a selected band of sizes and adding them in proper proportions. Second, the forming pressure to mold the brick has been stepped up from about 1,000 to 10,000 lb. per square inch, to reduce the voids between grains. This careful sizing has greatly intensified the effect of the ten-fold increase in pressure. Third, a refractory chemical bond is used, which contributes to the effect of the first and second improvements.

Both a Ritex magnesite and Ritex chrome are now in regular commercial production. The brick are strong and hard when cold; well bonded at very high temperature; and show only negligible volume change when heated to service temperatures. Their greatly increased density over burned brick contribute to their slag-resisting properties. The increased strength, density and volume stability of these products are also reflected in an outstanding property which distinguishes them from burned magnesite and chrome, namely, a high resistance to spalling. The latter effect in high-temperature furnaces is of course the resultant of a combination of factors such as textural changes resulting from shrinkage on continued exposure to high temperature and slag, as well as thermal shock.

This property of resisting spalling is brought out effectively in Fig. 3, which shows representative samples of Ritex chrome and regular burned chrome brick after a simulative service spalling test. On the left are shown the burned brick which vitrified, cracked and eventually lost about 22 per cent of their weight. On the right are shown the Ritex chrome which came through the test with no cracking, shrinking or loss in weight.

Insulating Firebrick—One of the important properties of refractories which fit them for their special field of engineering use is ability to confine heat. By inducing high cellularity and proper strength in refractory clays and other minerals there have been developed in the past few years refractories suitable for lining the interior of furnaces, thereby greatly increasing their ability to reduce heat losses. The cellularity of the mass in the commercial processes now in use is accomplished in a variety of ways, such as (*a*) by burning out a carefully sized combustible such as sawdust or cork; (*b*) by vaporizing at dryer temperatures a volatile organic material such as naphthalene; or (*c*) by combining gas bubbles with a finely ground plastic mass or slip. The bubbles may be produced by mechanical aeration; or by gas from a chemical reaction of certain batch constituents, followed in either case by stabilizing the foam so generated.

Most efforts to date have been directed toward producing brick with as high a thermal resistance as possible, without too much sacrifice in strength. This property is generally directly proportional to the bulk density of the product. Fig. 4 shows the variation in thermal conductivity, with density, of several cellular clay bodies at room temperature. Density of fireclay insulating firebrick ranges from 40 to 50 lb. per cubic foot and conductivity from 1.1 to 1.3. Diatomaceous earth brick, at one extreme, have a density of about 35 lb. per cubic foot, with a conductivity of about 1.0, and regular commercial firebrick, at the other extreme, with a density of nearly 130 lb. per cubic foot, have a conductivity of about the order of 3.0.

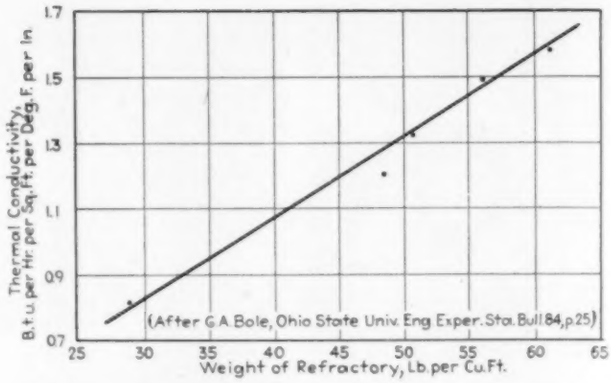


Fig. 4—Variation of thermal conductivity with weight of cellular clay bodies

Two other critical properties of these refractories are the shrinkage and spalling at furnace temperatures, which are more exaggerated than in the usual refractory. Both can be controlled to some extent by properly designing the mix.

Application of Newer Refractories

A great many chemical and metallurgical processes operating at high temperatures have long been confronted with the problem of attack of the basic oxides or slags incidental to the process, on the furnace refractories in use. Typical of these industries are those manufacturing cement and dolomite clinker, glass, basic open-hearth steel and the smelting and refining of copper. The basic refractories offered these consuming industries until within the last two or three years were generally satisfactory chemically, but not structurally. In particular the basic refractories were weak in their resistance to spalling and in their ability to carry loads at high temperatures. Accordingly, compromises have been made all along the line. One of the recent outstanding accomplishments in the application of refractories has made it possible for the consumer who must contend with basic fluxes to obtain a refractory which is proper both chemically and structurally.

For instance, the original type of lining for the hot zone of rotary cement and dolomite kilns was made of fireclay brick. Later came the high alumina brick of 70 per cent alumina because it had a higher pyrometric cone equivalent (P.C.E.) value of 37 (1,820 deg. C.) as compared with about 32 (1,700 deg. C.) for clay brick. Magnesite brick were recognized as the logical refractory, but because of the high spalling character of the burned brick, practically no cement kiln operator ever used them. He preferred to get along with a

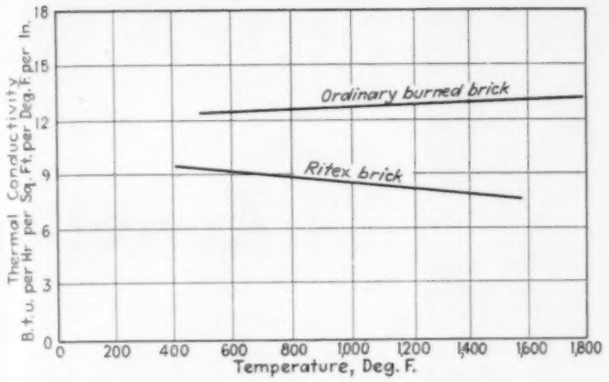


Fig. 5—Comparison of thermal conductivities of Ritex chrome and burned chrome brick

brick chemically wrong, but physically better. Ritex magnesite now have shown several years of extremely satisfactory service in this type of kiln and some interesting data in this connection have been compiled. In one cement plant, 27 former linings of either the 70 per cent alumina or fireclay brick type lasted an average of 54 days. This is to be contrasted with 310 days for one Ritex lining and 454 days to the date of writing, for the second. The production so far on the second lining has been about 7½ times that of the older type linings and the saving, based on lining cost per barrel of cement produced, is three times the cost of the lining still in service.

In the manufacture of glass, conducted at such high temperatures as 1,300–1,650 deg. C., the presence of soda is always a problem in the use of refractories for the superstructure and regenerator checkers. Furthermore, the glass, which is maintained well above its melting temperature in a fluid condition, acts as a solvent on the aluminum silicates used for the refractories constituting the tank blocks, port sills and jambs.

Silica brick are still generally used as roof brick because of their load-carrying ability, although they are decidedly acid and suffer corrosion from the soda dust. Advancement has been made, however, in refractories for the checkers. Two well-known properties of magnesite brick have long suggested them as the proper checkers for glass regenerators, namely, the fact that they have the highest heat capacity and conductivity per unit volume of any type of refractory which might be used, together with the ability to resist fluxing by the soda. Clay brick were used originally, then high alumina or kaolin. In the past year Ritex magnesite has been employed. After a year's service these brick were found to be clean and serviceable. They did not flux or spall and could be salvaged and reused, while kaolin and fireclay brick exposed simultaneously fluxed badly and had to be discarded.

Refractories for Molten Glass

At points where molten glass is the problem, electro-cast mullite and bonded cyanite are being substituted for clay in increasing tonnages. Electro-cast mullite is admirable for this purpose since the porosity is only about 0.5 per cent as compared with 22–29 per cent in clay flux blocks. Hence, the surface of the refractory exposed for solvent action is reduced to a minimum. Both electro-cast mullite and cyanite have the advantage of a P.C.E. value of about 37 as compared with 32 for clay brick, and a margin of safety is acquired before melting or reaction can proceed. In addition, the highly crystalline character of these two refractories, together with increased resistance to the solvent action of the glass because of the high alumina content of the mullite, make them improvements over clay brick.

In the field of ferrous and non-ferrous melting, the use of magnesite and chrome brick have long been established, particularly in hearths and bottoms, because of chemical resistance to the basic slags present. An acid refractory, silica, has been necessary for its strength, above the slag line and for the roof. The problem has become more acute with the higher refractory temperatures due to the increasing use of insulation on the outside of open-hearth sidewalls and roofs. Now, however, improvements in the physical character of chrome brick, both burned and Ritex types, have made it possible to make the logical substitution of these brick at many points. A definite heat economy further may be realized by the use of Ritex chrome brick which, as indicated in Fig. 5, has a much smaller heat conductivity than burned chrome and a negative temperature coefficient.

In reverberatory furnaces for smelting and refining copper is the same trend in the substitution of improved basic brick for silica brick at points other than bottoms. Such brick for roofs have given as much as seven times the life of silica roofs. Magnesium silicate brick from olivine have also been tried.

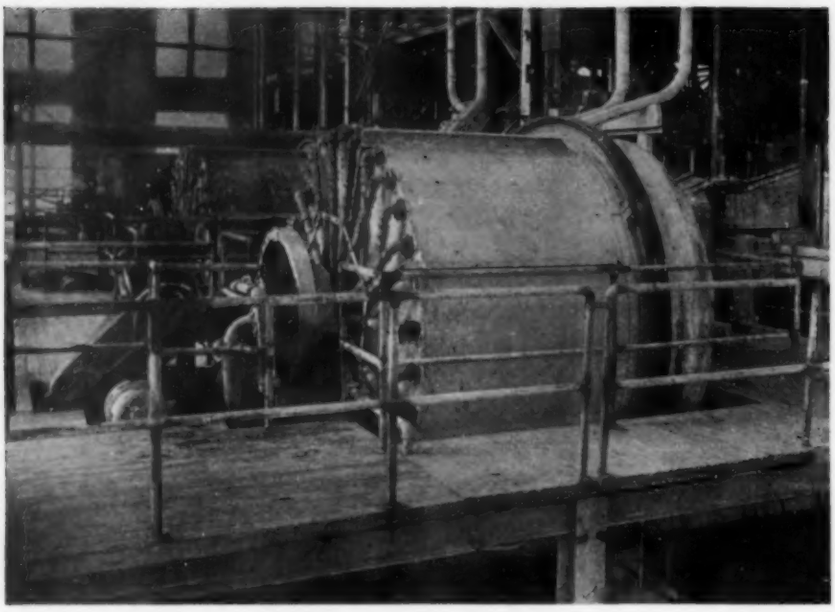
Boiler furnaces operated at high ratings, such as those in central power stations and in marine service, are proving to be a field of special application for the new super-duty fireclay refractories, because of the excellent spalling and slag resistance of these brick.

In small electric furnaces, domestic oil-fired heaters or for furnace walls where special or complex shapes are required which costs do not warrant making up in large amounts, it has been the practice to use rammed-in plastic linings of various refractory materials. It is now possible to obtain refractories with a hydraulic set which may be cast in place. A refractory high-alumina cement is used and castable mixtures from practically all refractory materials may be produced.

Stated generally, the most advantageous applications of the new insulating refractories as furnace linings are for intermittently operated furnaces. Such brick shorten the time required for heating-up by reducing the heat lost by storage in the walls. This is aside from the structural advantage of being able to make lighter weight furnaces.

Future developments in refractories will undoubtedly see a continuation of the trend toward improvement in physical properties. There will be less misfit use of refractories, a spread of the use of the improved basic brick, for example, with a decrease in the use of chemically unsuitable acidic brick. In the field of insulating refractories, cellulated products will undoubtedly be produced from materials other than fireclay as the demand arises. Should it be found possible, by some treatment of the fireface, to make insulating brick impermeable, a great obstacle to their use will be removed. With improvement in such refractories they may be expected to be used increasingly in the lining of furnaces, and in reducing furnace weight and heat losses.

Corrosion



Battery of filters constructed of phosphoric acid resistant materials in the plant of the Consolidated Mining & Smelting Co.

PRODUCTION of ortho-phosphoric acid and of superphosphates is complicated because of the corrosion difficulties, most of which can be attributed to impurities in the phosphate rock used as a raw material. Pure phosphoric acid has little effect on some alloys. Unfortunately, however, the purer acid has no important market, and the crude acid is much more corrosive. In discussing the corrosive effects of crude phosphoric acid on metals and alloys one must bear in mind that no two processes will produce acids of the same purity. The source of raw materials will likewise influence the purity of the finished product. Phosphate rock from Montana will have a different analysis from that of rock from Florida or Tennessee. The average of seven samples of crude phosphoric acid of American manufacture showed a P_2O_5 ranging from 40 to 58 per cent, SO_3 from 0.2-4.0, fluorine from 0.3-2.0, and arsenic from 0.1 to 1.75 per cent.

A wide variation in corrosion rates could be expected with acid containing different quantities of arsenic, SO_3, or fluorine. Presence of arsenic, for instance, inhibits the corrosion of iron and ferrous alloys. The phosphoric acid produced by Anaconda Copper Mining Co. at Anaconda, Mont., contains enough arsenic to reduce the corrosive action on iron and ferrous alloy to a marked degree. The problem there is thus much simpler than in the plant where an acid high in fluorides and sulphates is processed. Presence of some sulphuric acid aids in protecting lead because a protective film of insoluble lead sulphate is formed.

Dilute acid is almost invariably more corrosive than the concentrated form. This is due to the fact that the dilute acid contains more of the fluorides. The high temperatures involved in the concentration of the acid tend to distill off the fluorides. On the other hand, as the strong acid is prepared by evaporation or by the furnace process, pyrophosphoric acid may be formed, a more corrosive variety than the ortho-phosphoric acid.

A vast amount of information on the corrosion of metals and alloys by phosphoric acid has been accumulated. Industry has gathered most of this knowledge through the hard school of experience. It has been found that lead, silicon-irons, chrome-irons, and alloys high in nickel and chromium, like Pioneer metal, Illium, and the La Bour alloys have been the most useful. Recently installations of chrome-nickel-molybdenum steels (Cr 18-24 per cent, Ni 8-12, Mo 4) have been found very satisfactory. High chromium-iron (Cr 25-30) castings have been used for several years.

No metal or alloy has been found to resist the acid completely; consequently there is always some contamination by the metal of which the equipment is constructed. The phosphoric acid manufacturers who use their product for food materials (baking powder, phosphate syrups, and so forth) are prevented from using metals or alloys, corrosion products of which are forbidden by law in food products. Moreover, the slightest discoloration is looked upon with disfavor by the consumer. Thus, while the chromium-nickel-molybdenum steels are quite satisfactory as far as the life of equipment is concerned, they have not been used for apparatus in contact with the acid produced for food products. In these cases alloys like silicon-irons are used, which corrode much more rapidly but which give contamination products that are tolerated within certain limits. Large quantities of lead have been used satisfactorily in conjunction with this acid. Its use is limited, however, if the fluoride content is high and the SO_3 content of the solutions low.

In a recent investigation about 300 samples of over 80 alloys were obtained from manufacturers interested in the problem of developing an alloy resistant to phosphoric acid. These specimens were carefully cleaned, weighed, and placed in several lots of crude concentrated acid with varying analyses supplied by different producers. Tests were made at temperatures ranging

# of Metals by Phosphoric Acid

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from 20 to 98 deg. C. The time of exposure varied from 24 to 2,500 hours.

Alloys were first exposed to the acid at 95 deg. C. for 100 hours. Any alloy which showed hydrogen evolution was removed and graded as worthless. Certain of the alloys showed a loss of less than 0.500 gram/sq.dm./100 hr.—a figure arbitrarily taken as the maximum loss permissible for this temperature and this time interval. This group included: (1) high-chromium irons (Cr greater than 27 per cent); (2) nickel-chrome-molybdenum steels (Cr 18-30, Ni 8-12, Mo 3-4); (3) high chrome, low nickel irons (Cr greater than 27, Ni 3); (4) high nickel-chrome alloys of the Illium, G-60, Pioneer type; (5) Hastelloys C and D.

All of the above-mentioned alloys and some others showed a loss less than 0.100 gram/sq.dm./100 hr. at 20 deg. C. These include: (1) all stabilized 18-8 alloys, (2) Duriron and Durichlor, (3) Elcomet L, Inconel, (4) Hytensyl bronze, (5) lead and antimonial lead, and (6) chrome-nickel-iron alloys (Cr greater than 22, Ni greater than 10).

The alloys showing a loss less than 0.500 gram/sq.dm./500 hr. at 95 deg. C. are: (1) nickel-chrome-molybdenum steels (Cr 18-30, Ni 8-12, Mo 3-4), (2) chrome irons (Cr 30), and (3) Hastelloy D. It must be remembered that at the end of the test the acid was not as corrosive as at the start of the test, because of the constant loss of hydrofluoric acid due to volatilization.

Those alloys showing a loss less than 0.100 gram/sq.dm./2,000 hr. at 20 deg. C. are: (1) the groups of alloys mentioned in the last paragraph, (2) G-60, Illium and Pioneer metals, (3) Hastelloys A and C, (4) Duriron, (5) lead, (6) stabilized 18-8 alloys, and (7) chrome-nickel ferrous alloys (Cr 24, Ni 12).

The importance of low carbon in the 18-8 alloys can be seen from the following data referring to tests on two 18-8 alloys, one of which contained 0.15 per cent carbon, the other 0.07 per cent. The tests were carried out in a concentrated fluoride-free phosphoric acid for 100 hours.

Temperature	Loss/Sq. Dm./100 Hr.	
Deg. C	Low C (0.07)	High C (0.15)
25	0.0160	0.0425
50	0.0260	0.0570
60	0.0034	0.4255
65	0.0081	25.7728
75	3.0402	44.7230

These tests show the important influence of temperature as well as carbon content on the corrosion rate of the 18-8 alloys. Other tests indicated that carbon exerts a similar effect on the chrome-iron alloys. Considerable work has been done on stabilizing the carbon content in the 18-8 alloys by heat treatment; by a lowering of the carbon content; and by the addition of elements like molybdenum, titanium, columbium, and so forth.

Temperatures above 65 deg. C. indicate a startling increase in the corrosion rates of metals in this acid. This temperature may be a critical point for the breakdown of the normal passive films or for the formation of the more corrosive pyrophosphoric acid.

Lead-lined evaporators for the concentrating of phosphoric acid

Alloys That Resist Severe Corrosive Conditions

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TWO CONSIDERATIONS govern the use of corrosion-resistant steels in the petroleum and other process industries, the economic factor and the ability to accomplish results. To study the economic factor and to estimate the cost of equipment it is necessary to determine the corrosion rate and the expected life of the various types of materials.

An important point in the chemical and food industries is the purity and color of the product; here two alternatives may present themselves: To use a material of construction that will impart discoloration or impurities to the products being processed and then to remove these discolorations and impurities by special processing; or to use a corrosion-resistant material that will prevent such occurrences. The cost of replacing corroded parts and the subsequent loss of production due to shut-downs must also be taken into account in obtaining the true economic answer.

In regard to the ability to accomplish desired results, there are many instances where a high-alloy steel must be used, on account of temperature, while in other cases the purity of product demands a corrosion-resistant steel.

Among the equipment encountered in the petroleum refining industry are cracking still tubes, heat-exchanger tubes, condenser tubes, soaking drums, evaporator towers, bubble towers of various kinds, and heat-exchanger and condenser shells.

Sulphur Compounds Plus Hydrochloric Acid

For still tubes and heat-exchanger tubes, the problems are about the same, except that furnace tubes are exposed to higher temperatures, with furnace gases on one side and petroleum and petroleum gases on the other, while both sides of the heat exchanger are in contact with liquid or gaseous petroleum, usually at a lower temperature. In such tubes we have both corrosion and erosion, the main corrosive agents being sulphur compounds and hydrochloric acid.

The inlet temperature to cracking coils from hot oil pumps ranges from 550 to 700 deg. F., with the outlet temperatures as high as 1,050 deg. for low pressure and slightly lower for high pressure; the outlet temperature of reforming coils is from 1,020 to 1,030 deg. Corrosion generally starts at the point in the coil where vaporization begins. In heat exchangers the difference in temperature between the two sides of the tubes may run as high as 525 deg. F. with temperatures up to 1,030 deg. F. on the hot side of high-pressure units.

Cracking, viscosity breaking, and reforming coils as well as heat-exchanger tubes may be of carbon steel, carbon-molybdenum, low-chromium carbon-molybdenum, 4-6 chromium-carbon-molybdenum, KA2S, KA2ST, or 27 chromium, as economy may dictate. The first corrosion-resistant tubes used in oil cracking were 18-8, but as the temperature range in cracking is that at which carbide precipitation takes place in this alloy, and on account of high first cost and cost of precautionary measures to operate successfully tubes of 18-8 steel have been replaced almost entirely by 4-6 chromium-molybdenum tubes, for handling corrosive crudes.

4-6 Chromium Satisfactory

No appreciable corrosion takes place with 18-8 or 27 chromium tubes, but their high cost and the problem of brittleness must be considered. It is indicated that 18-8 tubes, stabilized with titanium, may be satisfactory, but no actual installations of these tubes have been brought to the writer's attention.

Plain 4-6 chromium tubes were the first low-chromium still tubes used in handling corrosive crudes; where carefully handled they have been most satisfactory. This alloy is subject to temper brittleness and many tubes cracked in cleaning or on cold test after a shutdown. Addition of 0.5 per cent molybdenum apparently inhibits this temper brittleness and adds so much to the strength of the alloy between 900 and 1,050 deg. that 4-6 chromium-molybdenum is now universally accepted in this service. Average corrosion resistance of 4-6 chromium-molybdenum tubes when the chromium content is over 5 per cent compared with carbon steel tubes under the same conditons is on the order of 1:15.

Condenser tubes offer far the most difficult corrosion problem in oil refining. When it is considered that either sulphurous or acid-bearing gasoline vapors are being condensed on the outside of the tubes, with very corrosive water on the inside, it is not difficult to understand the truth of this statement.

All of the corrosion problems, including electrolysis, inherent to central station steam condensers handling such waters as are found in the Gowanus Canal are encountered in gasoline condensers handling these waters.

Heat-exchanger shells of comparatively small size

Based on paper presented before New York Section of the American Welding Society, May 15, 1935.

and thickness have been and are being manufactured from corrosion-resistant steels, particularly KA2S and KA2ST, and I predict that the use of such shells will increase.

The problems of the process industry, such as soap, vegetable oils, pulp and paper, and the food industry do not differ from the problems of the petroleum industry except in degree. However, in these industries the problems are almost always problems of corrosion, discoloration or contamination of product, and corrosion-resistant alloys are being used in ever-increasing quantities. In these industries are encountered nitric acid, fatty acids, caustics and other corrosive agents, the successful handling of which requires tubes and welded vessels of KA2S, KA2ST, chromium-iron of various analyses, high chromium containing molybdenum or nickel, the manufacture of all of which present many fabrication problems.

Use Welding and Protect the Worker

Welding of high-alloy steels requires drastic departures from established welding procedure and heat-treatment. Each alloy has its own idiosyncrasies, and before a given alloy is fabricated into a pressure vessel these should be definitely established and methods developed to effectively take care of them. This is not only of primary importance to protect the lives of those who are to work around the vessels, but it is also important to protect the purchaser's interest in providing him with a vessel with the expected service life.

As these alloy steels are quite expensive, the cost of welding and testing full-sized pressure vessels for experimental purposes is also prohibitive. The primary reason, of course, for wishing to weld full-sized vessels is to determine their fabricating characteristics under shop conditions. The physical properties and corrosion-resistant properties of the weld and welded joint may be determined on welds made on smaller specimens. In order, however, to simulate as nearly as possible conditions which may be met in regular shop production, small diameter vessels with a high ratio of thickness to diameter may be fabricated in such a way that the shrinkage strains in welding are exaggerated to a point where it is felt that the normal difficulties of shop fabrication are simulated quite closely and in fact very probably exceeded.

Fabricating Characteristics

In investigating the fabricating characteristics of several of the high-alloy materials, the M. W. Kellogg Co. built a vessel of each alloy selected, 14 in. inside diameter, 2 ft. long, and $\frac{1}{2}$ in. thick. After the straight weld was made and X-rayed, the vessel was cut in half transversely, and a $\frac{1}{2}$-in. thick disk 14 in. in diameter was placed under the center of a girth weld between the two halves of the vessel. In welding the girth seam, care was taken to fuse the edges of the plates into the solid disk below. The weld was then completed in the normal way. The idea of the solid disk below the girth weld was to exaggerate as much as possible the strains produced by shrinkage in the weld. It was felt that if a vessel constructed in the above manner could be made without unusual difficulties, the same could in all probability be done with most of the ordinary types of pressure vessels.

In addition, a complete chemical analysis of deposited weld metal and base plate was made. The vessel was heat-treated in accordance with recommendations made by the manufacturer of the steel. In some cases additional heat-treatments were added to determine their effect. After heat-treatment, physical tests were run on all-weld-metal tension bars, reduced tension bars, bend bars, and Charpy impact tests were made on weld, adjacent area and base metal. A thorough microscopic examination was made of welded joint and base metal at 100 X and 1000 X after a passive treatment. Corrosion resistance was determined by the Huey test, each sample being run for five 48-hr. periods in 65 per cent boiling nitric acid. Tests to determine the susceptibility to inter-granular corrosion were also conducted by immersion of the sample in boiling 3 per cent $CuSO_4$ -10 per cent H_2SO_4 for 72 hr., after which it was removed and bent as a free bend, elongation and angle of bend being measured and the condition of the fracture, if any, noted.

The above tests are probably the best accelerated corrosion tests known today, but it must be emphasized that they can by no means be relied upon to give the corrosion resistance in all media. Where possible, samples should be tested under actual service conditions, because this is the only way of getting actual operating data. This usually requires a great length of time and some sort of accelerated test must be resorted to.

Sub-Zero Temperatures

Rockwell hardness determinations were made throughout the welded area and in the base metal of each material. A complete report covering the welding characteristics of the rod and any troubles encountered was kept in each case and formed a part of the test data.

One very important property to determine in any untried material is its susceptibility to temper embrittlement. As mentioned before, a great deal of trouble was experienced in the oil industry with straight 4-6 chromium because of this material's susceptibility to temper embrittlement after service at high temperatures. The only accelerated test known by the author to determine this property of a material is one which was developed by Greaves and Jones for tool steels.

In the petroleum and chemical industries pressure vessels and tubes have to operate at sub-zero temperatures, and as it is a fact that certain materials lose almost all their resistance to shock at low temperatures, their resistance to shock at operating temperature should be investigated thoroughly in addition to their weldability.

In closing, it is necessary to emphasize the fact that too much care cannot be exercised in the investigation of any new material before it is put into service. Such investigations protect not only the ultimate consumer, but the fabricator as well, and after new materials have been installed careful operating records should be kept so that the operating data of experience can be added to the data based on research. Experience and research should go hand in hand, and I again make a plea for closer cooperation between the manufacturer of the material to be fabricated, the fabricator and the consumer in problems of research and development.

Fatty Acid Distillation Advanced

A distillation process has been developed by Stanley Goranflo at the Philadelphia plant of Wilson-Martin Co., which has given increased throughput, higher yield and better quality. Exceptionally high yields of deodorized products have been obtained also from cotton seed, peanut, corn, rape, palm or coconut oil fatty acids as the charging stock

IMPROVEMENTS in the fatty acid distillation and purification plant of the Wilson-Martin Co. at Philadelphia have resulted in increased throughput, higher yield and better quality. The efficiency of the unit and the quality of the distillate are dependent upon the pressure, temperature and heating rate at different stages of the process. The actual values of these factors are, therefore, mentioned in the description of the process. The superheater, bubble tower, heat exchanger units and the other equipment give this installation the appearance of a small petroleum refinery.

The principal raw material is beef tallow stock. This is received at the plant in tank cars and barrels from which it is removed by steaming. It is pumped directly to the Twitchell fat splitting process equipment, where the glycerine is extracted and sold in crude concentrated form, and the fatty acid stock containing from 92 to 96 per cent free fatty acid is pumped to the vacuum distillation plant shown in the accompanying diagram.

The charging stock enters the heat exchanger at a temperature of about 150 deg. F. and is preheated by the vapors from the bubble tower to approximately 350 deg. Before going to the bubble tower the temperature of the stock is raised rapidly to about 480 deg. by superheated steam in the final heater. To prevent local overheating the rate of flow is maintained sufficiently high to create turbulence in the fluid stream.

Sufficient steam enters the superheater through the thermocompressor to make up for that used in the bubble tower. Some of the steam leaving the superheater at 750 deg. F. simply returns through the final heater at 500 deg., while a sufficient volume goes to the tower to maintain the bottom tower temperature at 600 deg.

The steam rises countercurrent to the stock in the bubble tower and carries the fatty acid vapors with it through the outlet at the top of the still at a vapor velocity of 2 ft. per sec. under a 24-in. vacuum. The vapor outlet temperature is 450 deg. F. The vapors pass through the heat exchanger used to preheat the charging stock and then to a spray condenser where they are cooled to 200 deg. under a 26-in. vacuum. The condensed fatty acids are collected in the separator and withdrawn from the bottom, while the vapors leave from the top for condensation in the final condenser and collection in the receiver. The steam is withdrawn from the top of the receiver. The vacuum on the receiver is about 29 in.

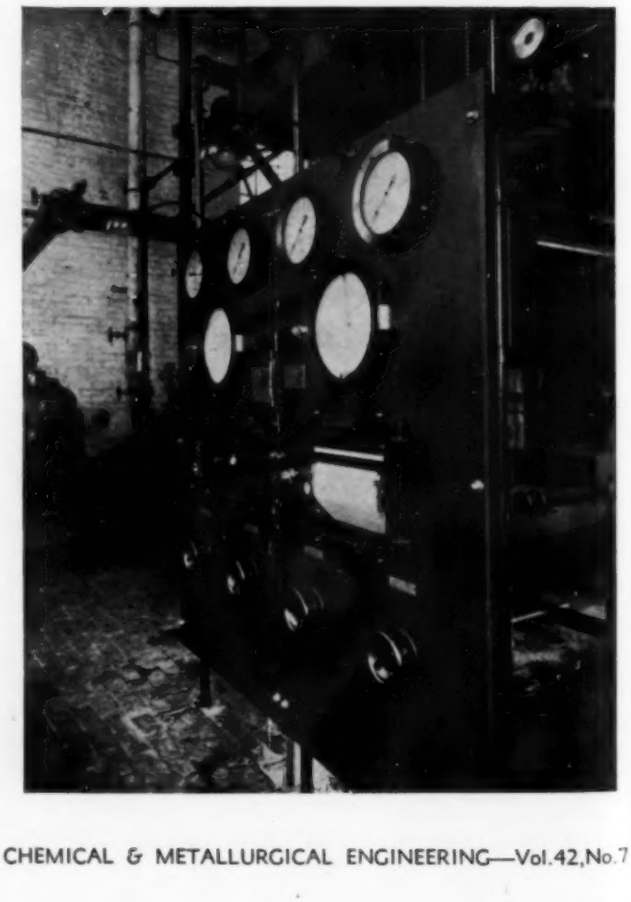
The greater part of the condensation takes place in the spray condenser and very little in the final receiver. Operating conditions are such that condensation is carried out above the boiling point of water and below the boiling point of the fatty acids. The absence of substantial quantities of water eliminates emulsification difficulties and, in addition, the odoriferous portions are steam soluble and are carried away by the steam, leaving an odorless distillate.

The still bottoms may be recirculated from the pitch pot through the lower plate in the bubble tower, but as the level builds up they are withdrawn through the vacuum release into drums. This black residue is marketed as animal pitch and is used in the manufacture of slow-burning electrical insulation.

During a 90-hr. run, 129,039 lb. of 95 per cent free fatty acid stock was charged with a recovery of 116,394 lb. having an N.P.A. color of $1\frac{3}{4}$. This represents a yield

Instrument Panel Board

Thermocouples T 1 to T 6 are connected to a Brown 6-point recording potentiometer, mounted on the board. These six temperatures are essential in the operation of the unit and are, therefore, recorded so that the trend can be observed. In addition a Brown indicating potentiometer, in combination with a multiple-point switch is used for periodically observing the temperature of other points in the process. Indicating vacuum and pressure gages, a recording 12-in. vacuum gage, and a recording integrating steam flow meter, complete the instrument assembly on the panel board, and provide necessary information from a central location



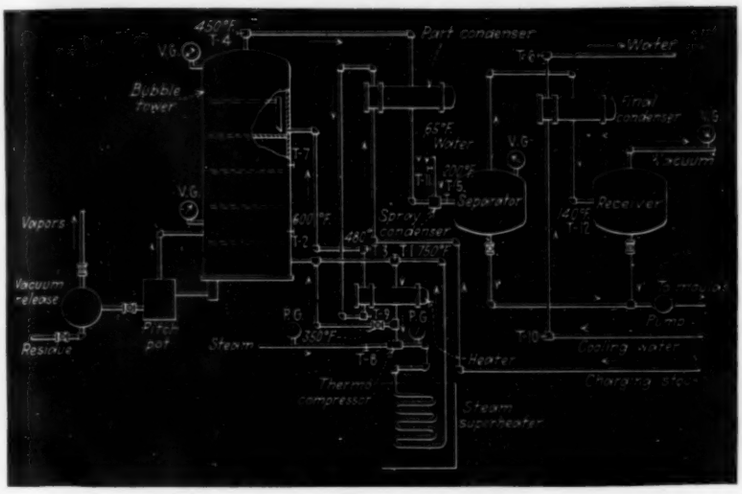


Diagram of vacuum distillation plant

of more than 90 per cent. During this run, 89,760 lb. of steam at 750 deg. F. was used. The bubble tower has a capacity of 650 lb., which allowed 24 minutes for the stock to pass through the tower. At this velocity, the stock was heated at the rate of 12 deg. F. per min.

The stearic and oleic acids contained in the distillates are separated in the following stages: crystallization, cold pressing, melting, recrystallization and hot pressing.

This system of fatty acid distillation was developed by Stanley Goranflo and assigned to the Wilson-Martin Co. under U.S. Patent No. 1951241. He has made a number of test runs using cotton seed, peanut, corn, rape, palm or coconut oil fatty acids as the charging stock, and has obtained exceptionally high yields of deodorized products.

The operator of the unit is guided by the instruments on the panel board so that he can maintain the correct temperatures, pressures and heating rates in the different stages of the process for the different charging stocks. For example, a palm oil containing 13.5 per cent free fatty acid has been refined to an 0.8 per cent free fatty acid content on a single pass through the still, and produced a distillate of good color. Equivalent results were obtained when other vegetable oils were used.

Producing Nicotine In Virginia

AMONG the enterprises of Virginia falling under the heading of chemical industries, one of the most unusual is the extraction of nicotine, which is being done by the Tobacco By-Products Corp., of Richmond, Va. An account of the process and applications was presented in a paper on chemical industry in Virginia, by C. Braxton Valentine, before the Virginia Academy of Science, at the annual meeting held at the University of Richmond, May 4, 1935.

Nicotine was isolated from the leaves of the tobacco plant by Posselt and Reimann, in 1828. The quantity found varies considerably, from 0.6 to 8 per cent. In general the better grades of tobacco contain the smaller quantities of the alkaloid. The empirical formula of nicotine, $C_{10}H_{14}N_2$, was established by Melsens in 1843.

The commercial extraction processes of nicotine depend on the ready solubility of nicotine or its salts, in organic solvents, water, or steam. In case of organic solvents the salts are converted to the free alkaloid by a suitable alkali, soda or lime, and the alkaloid is dissolved out by the organic solvent; almost any organic solvent can be employed. One commercial operation employs carbon bisulphide. The nicotine is removed from the solvent by scrubbing with an acid solution, generally sulphuric acid. This produces a sulphate of varying purity and strength, and certain refining steps would be necessary in the usual course.

Another means of extraction employs water which dissolves both free nicotine and its salts. The solution is made alkaline, extracted with an organic solvent, which in turn is recovered with an acid, as in the preceding case. In the first process, the residual matter is left in a condition suitable for sale for fertilizing materials. In the water extraction the residue is almost valueless, as the fertilizer value is necessarily low and the water content so high that drying is prohibited.

The third process involves extraction with steam; the nicotine is liberated by an alkali, and removed by steam distillation. This is the process operated by the Tobacco By-Products Corp. Nicotine is removed from the steam by scrubbing with sulphuric acid, a patented feature. However, the patents covering steam extraction have expired.

The tobacco plant which serves as raw material may be a very small weed the leaf of which is as small as that of an elm tree; through numerous variations it is found in sizes up to a large tree. Normally, it is an annual; the tree variety, of course, is a perennial. Getting back to commercial sources, the manufacture of cigarettes, pipe tobacco and chewing tobacco, produces substantial quantities of waste material in the form of dust and stems. The nicotine industry serves as the outlet for this waste product, salvaging the nicotine and fertilizer values.

As to the uses of nicotine, it serves the florists and greenhouse men in two ways—for spraying and fumigation. In animal husbandry, nicotine is used extensively for dipping cattle, for scab-mite, lice, and sheep-tick. In the poultry field, nicotine is used for internal parasite control and for fighting body lice and mites. In the truck gardening field application—as spray, or in dust form—is quite wide, for the control of many insects. The largest usage is in connection with commercial fruit growing, particularly in apple orchards. Black Leaf 40 (nicotine sulphate) is a standard remedy in home gardening, for aphis on flowers and shrubs, and as a repellent for dogs.

Modern Sulphur Burning Approaches Ideal Performance

By MURRAY E. OTHMER
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Bound Brook, N. J.

FOR MANY YEARS, sulphur has been burned in a variety of ways. Equipment for burning varies in size and efficiency from the small pot burners used in the beet sugar and cider plants to the huge roasting furnaces of ore smelters. When a few pounds, or hundreds of pounds, of sulphur a day are consumed, little attention is paid to burner efficiency other than to keep the obnoxious sulphur dioxide gas from escaping into the atmosphere breathed by the operators. Where sulphur dioxide is produced in large quantities, however, it becomes essential to regulate its quality in rigorous fashion. The production of a steady stream of gas with a constant composition is of the greatest importance in the sulphuric acid and sulphite manufacturies, both of which are large users of sulphur dioxide. This is true whether the material being burned is pyrite or brimstone.

Since the commercial advent of the contact process early in this century, large quantities of brimstone have become available and the continuation of these factors has stimulated much technical thought on the development of sulphur burners. Only a few of the many kinds of equipment evolved can be discussed here, but the outstanding developments will be compared from both the theoretical and practical points of view. Structural details will be considered only when necessary, since these have been itemized in the patent literature and elsewhere (Wells and Fogg. Dept. of Int. Bull. 184, p. 59-65; Spangler, *Paper Trade J.*, **94,** 1932, p. 51; Dinsmoor, Trans. Am. Inst. Chem. Eng., **26,** 1931, p. 158).

Burner Requisites

The major purpose of a sulphur burner used in a contact acid plant is to convert sulphur into sulphur dioxide and to accomplish this at minimum cost in such a manner that the resulting product, after passing through the converter, will yield the highest possible amount of sulphur trioxide from the sulphur fed to the burner. Molten sulphur itself has a high vapor pressure and sublimed sulphur in the gases produced is not only an economic loss, but plugs filtering apparatus very quickly. The burner must be capable of supplying a gaseous mixture containing as high as 10 per cent of sulphur dioxide gas free of sublimed sulphur. The gas entering the converter must be free from impurities which would decrease the effectiveness of the catalyst and this gas must contain a constant concentration of sulphur dioxide when delivered; otherwise, rapidly varying temperatures in the converter follow which result in poor conversions. Furthermore, the gas concentration must be capable of sufficient regulation to meet production requirements.

All of the sulphur fed must be burned and the whole of the resulting gas delivered to the converter with the least possible sulphur trioxide content. This is necessary in order to decrease the corrosion caused by the precipitation of weak sulphuric acid formed in the presence of moisture when the gas is cooled previous to its admission to the converter. The complete combustion of the sulphur must be effected in as short a time as possible, as this means conserving the heat of combustion, thus vaporizing the sulphur at a more rapid rate, which facilitates its complete burning. The burner should be gas tight and its air supply as free from moisture as possible; first, in order to decrease corrosion caused by weak sulphuric acid precipitation as previously noted, and second, in order to eliminate the loss of sulphur dioxide occurring through its absorption in sulphuric acid when the dehydrating tower is located between the burner and converter.

In this connection, it should be noted that many plants employ two sulphur dioxide scrubbing towers. The gas passes first through a scrubbing or "hot" tower kept between 40 and 80 deg. C., the function of which is four-fold: to eliminate dust and catalytic poisons from the gas; to act as a gas cooler; to return to the system much of the sulphur dioxide absorbed in the second, or "cool," scrubbing tower acid with which it is fed; and finally, to act as an absorber for part of the sulphur trioxide formed in the burner. It will be seen that this system is expensive and is automatically eliminated by preburner dehydration and the use of high-grade sulphur.

Actual operation of the burner must be simple; corrosion, moving parts, power, cleaning, and repair costs held at a minimum.

The preceding paragraphs picture the sulphur burner needed for efficient plant operation. Some of the modern types have exceeded these requirements while there are still other desirable features which have not yet been attained. These developments will be discussed later.

Flat Burner

Probably the oldest type of burner which is still being used for the production of sulphur dioxide in quantities is the so-called flat burner, a low-built iron casting with a semicircular or "D" shaped cross-section. These burners are small, approximately 10 ft. long, 2 ft. wide, and 18 in. deep; consequently, several units are necessary for even a small plant. The units themselves are usually arranged in banks set up on rollers to allow

for expansion and contraction of the castings. Sometimes an arch of firebrick is used rather than the iron casting, in which case, the curvature of the burner is above the burning sulphur rather than below as in the casting.

Besides having only a small capacity, these burners require excessive floor space and are extremely difficult to control. Excess sulphur sublimes very easily in them and since auxiliary burners are rarely used, this constitutes a perpetual source of trouble. Impurities gather quickly both at the surface of the molten sulphur and in the bottom of the pans, causing a gradual deadening of the fire and frequent burner cleanings, both of which occasion much loss of time and waste of unburned sulphur. At present, this type is being used chiefly as a "booster" in ore-smelting plants.

Glens Falls Burner

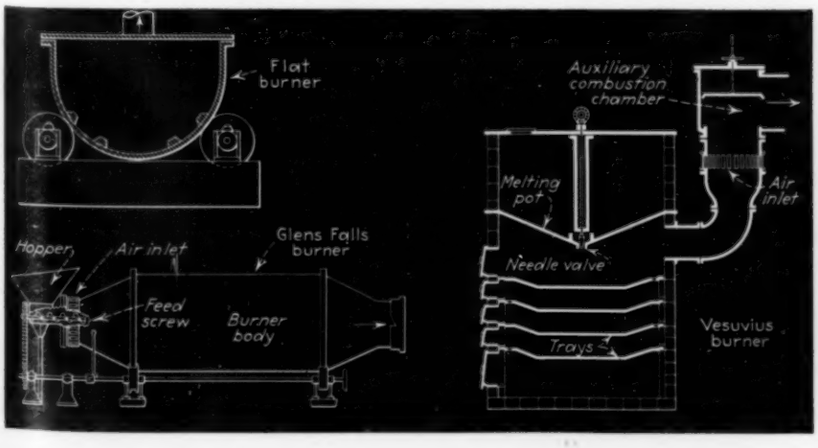
The gross inefficiencies of the flat burner left much to be desired and one of the early, important improvements came in the Glens Falls rotary burner. This burner has much to recommend it and is still being used in a large number of contact plants throughout the world. Like the flat burner, it is a horizontal furnace, but here the resemblance ends. The rotary burner is a cylindrical shell fitted with conical ends. It is rarely over 16 ft. long by 4 ft. in diameter, but this size can be made to burn 15 tons of sulphur per day. The cylindrical portion is of ¼-in. steel plate and flanged to the cast-iron cones on either end. These flanges are machined to run on trunnions which revolve the shell continuously at approximately ½ to 1 revolution per minute. The forward end is equipped with a hopper and screw for feeding sulphur and a circular damper for air regulation. The rear end is connected with a combustion chamber, usually a steel tank lined with firebrick, in which the combustion of unburned, sublimed sulphur is completed. This connection is made by a sleeve in which are located several slide dampers to admit additional air for completing combustion.

Since sulphur is a very poor conductor of heat, the burning, molten film which continually covers the inside of the shell forms a good protection from corrosion. Theoretically, with the continuous feed supplied by a chain-driven worm from the hopper, a constant percentage gas should be easily obtained. In practice, this is partially true, but several difficulties are involved. The operator must be extremely careful to allow no lump of sulphur larger than the worm will handle to enter the hopper. If this does happen, all of the sulphur in the hopper must be shoveled out to remove the clog, during which time the molten sulphur level in the burner is changing and, along with it, the gas concentration. Another difficulty occurs in the use of the chain-gear drive. It is almost impossible to fit the worm feed with a gear ratio which will hold the sulphur at a constant level in the burner. Room temperature and varying weather changes affect the rate of burning of the sulphur, since the oxygen supply is taken directly from the atmosphere. Consequently, to effect a constant gas concentration, different gear ratios are required, often from hour to hour, making it impossible for an operator to keep the level of molten sulphur in his burner constant at all times.

Power costs are higher, with this type of burner, as the entire cylinder must rotate continuously, and power is required to operate the sulphur feed; but repair costs are low and, usually, twice a year cleaning is sufficient. The gas coming from the burner is higher than minimum in sulphur trioxide content and must be cooled and reheated before conversion to effect dehydration. A quick shutdown of the burner is impossible without sulphur waste as the entire furnace charge must be burned out if a shut-down over any length of time becomes necessary.

Recently, the drum type of burner has been made gas-tight by encasing the whole, moving parts and all, excepting the sulphur hopper which is allowed open to the air. Since the hopper is kept full of sulphur at all times, the small amount of air entering through this channel is negligible. The advantages of this are obvious; the encased burner may operate under pressure at a much higher temperature with a minimum production of sulphur trioxide. The air supplied for combustion may be dehydrated before entering the burner, thus making it necessary to cool the resulting gas only to the temperature of its entrance to the converter. This saves much maintenance, since the blower handles only clean, dry air rather than hot, corrosive gases. Then, too, the exact control of the quality and quantity of the air supply means much simpler gas regulation.

Three earlier types of sulphur burner



Vesuvius Burner

The Vesuvius burner was the first large-scale practical type of furnace to employ the principle of melting sulphur before introducing it into the burner. This feature cuts down appreciably the accumulation of impurities within the burner by the simple expedient of melting tank separation by settling.

The Vesuvius burner is a vertical stationary, cylindrical shell containing a series of dished trays surmounted by a melting pot which is fitted with a needle valve controlled by a screw to regulate the flow of molten sulphur into the burner

proper. The cast-iron dished trays are spaced one above the other, with overflows alternating from front to rear and provide burning surfaces for the molten sulphur. Each tray is supplied with a door hinged at the top and contains a circular damper for cleaning and draft regulation.

In operation, dry sulphur is dumped into the melting pot where much of the heavy impurities is trapped. The molten sulphur drops, by gravity, from the melting pot into the burner, overflowing from tray to tray, the lighter impurities being thus carried continuously to the bottom compartment and the heavier settling to the bottoms of the various trays. This gives a continuously clean, bright fire. The pans are cleaned about twice a month with no need for shutting down the burner since the débris is scraped from pan to pan until it is all dropped into the bottom compartment from which it is removed.

The gas leaves the Vesuvius burner through a large pipe extending directly into an elbow. The upper end of this pipe is an auxiliary combustion chamber, slotted and fitted with a circular damper to regulate the air entering it.

Theoretically, a constant feed should be a simple matter with such a burner, but practically, it is rarely accomplished. Dry sulphur enters the melting pot as charges rather than continuously, so that the heat of fusion of the sulphur, together with the changing sulphur level, gives the stream dropping into the pans a varying viscosity. Consequently, a continuously dry feed to the melting pot is necessary if a continuous molten feed to the pans is desired, thus involving all of the difficulties experienced in the rotary burner feed.

Various methods have been used for rapid indication of proper burner functioning to give the desired gas concentration. Among the oldest were the flame color test and the depth of sulphur in the pans. Even the combination of these two methods, however, gave poor results. At present, recording pyrometers installed immediately behind the auxiliary combustion chamber in the sulphur dioxide line are used in the Vesuvius burner to indicate steady gas concentration. In the range usually desired for contact plants (7–9 per cent SO_2), the temperature variation is in the order of 1 deg. C. per 0.01 per cent SO_2 change.

In general, the new advantages brought about by the Vesuvius were that the burner required no power for operation and gave a continuously clean, bright fire.

Chemical Construction Burner

There has long been a dispute between practical and theoretical acid men over the degree of dehydration which should be attained in the sulphur dioxide gas entering the converter. Theoretically, the drier the gas, the better the conversion, the less corrosion of equipment, and the less sulphuric acid mist. Practically, there is a degree of dehydration beyond which no difference in conversion efficiency can be noted and the small excess of acid mist which escapes from a plant where the dehydration is carried to the practical optimum, rather than maximum, is of minor consequence. In the past few years, however, two radically different types of burners have been evolved which give the advantages of maximum dehydration to the entire plant, rather than only to that portion in which sulphur trioxide is handled as was previously true, and this dehydration is accomplished more cheaply than can be done partially in the older types of burners.

One of these is the Chemical Construction burner, a gas-tight, steel, cylindrical shell lined with insulation and firebrick. In this burner, the melting pot principle of the Vesuvius is expanded to a much greater degree of usefulness. The heat of combustion of the sulphur is still used to melt the solid, although indirectly as will be shown later, but the pit is much larger, holding approximately a four-day supply of sulphur rather than a few hours' supply. This makes an efficient settling tank in which the sand and heavy dirt are given ample time to settle and a surface from which the light floating dirt may easily be skimmed. A submerged pump with its intake half-way between the molten surface and the bottom of the pit pumps clean, molten sulphur to the burner.

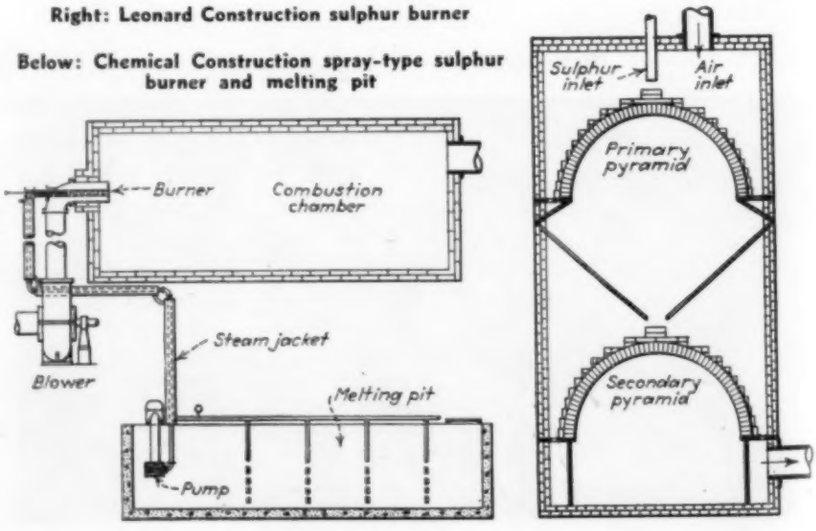
Sulphur feed enters the furnace as a spray and burns as does oil in mechanical oil burners. Air for combustion enters under pressure through an annular opening surrounding the sulphur entrance. This air is completely dehydrated before entrance in two drying towers, in one of which 93-per cent sulphuric acid is circulated, while mechanical sulphuric acid spray is caught in the second. A blower, handling only clean, dry air, is located between these drying towers and the burner. This blower supplies the pressure required to force the gases through the entire system. There is no auxiliary combustion chamber as the air blast mixes thoroughly with the sulphur vapor, thus precluding any such need.

After combustion, the hot sulphur dioxide gas passes through a waste-heat boiler where its temperature is reduced to the optimum for entrance to the converter. The steam so generated is used in the steam coils of the melting pit, to operate the turbine centrifugal pump for supplying the burner sulphur feed, and, in larger installations, to operate the air blower also.

With this development, a burner has become available in which the combustion of sulphur can be stopped

Right: Leonard Construction sulphur burner

Below: Chemical Construction spray-type sulphur burner and melting pit



almost instantly by shutting down the sulphur pump. The temperature of the exit gas is always a direct indication of sulphur dioxide concentration and this can be regulated easily by changing the speed of the sulphur pump, by regulating the amount of air entering from the blower, or by changing the size of the opening in the sulphur "gun." Since it is a pressure burner, it has a much greater capacity in a smaller space. There are no moving parts and hence, repair costs remain at a minimum. The sulphur trioxide content of the burner gas is decreased by the high temperature maintained. The efficient insulation of the burner conserves the heat of combustion, which effects instantaneous evaporation of sulphur during operation and allows shutdowns for as long as 24 hours without the necessity of preheating the burner to re-effect sulphur ignition. Corrosion from the burner gases is greatly decreased as it has been found that dry sulphur dioxide does not affect iron.

Leonard Construction Burner

Shortly after the Chemical Construction burner became available, the Leonard Construction burner was introduced. This furnace, too, was designed to eliminate the inefficiencies of the older types. It is interesting to note that as the Vesuvius and Glens Falls burners differed radically in outward appearance, and but little in results attained, so do the Leonard and Chemical Construction burners have little in common when compared superficially, while both have succeeded in eliminating many of the same operation inefficiencies.

The Leonard Construction burner uses a four-day-supply melting pit. A submerged pump delivers clean, dry, molten sulphur to the burner although the sulphur may be introduced in the solid form if desired. The liquid feed is, of course, preferable whenever practical and is forced to the burner by a deep-well plunger pump of variable speed. This type of pump has the advantage of putting greater pressure against any possible clog in the feed line than can a centrifugal, but has the disadvantage of occasional piston-ring sticking.

The burner itself is a vertical steel cylinder lined with firebrick. The sulphur is simply dropped, or pumped, into the cylinder chamber and falls upon a distributing plate at the apex of a brick checkerwork pyramid upon the surface of which combustion occurs. All of the sulphur is either burned or vaporized in this chamber from which the vapors pass to a second chamber where final combustion takes place.

Dehydrated air may be forced into the primary chamber, or air taken directly from the atmosphere allowed to enter; in either case, baffles are provided to distribute the air uniformly around the pyramid. Secondary air is introduced between the two chambers which are located one above the other so that any unburned sulphur may flow with the vapors from the first chamber checkerwork to the second where combustion is completed.

The rate of combustion in this burner is approximately the same as in the spray type, the sulphur being burned out within a minute after the sulphur stream is stopped. Temperature is used as a gas strength indicator and gas regulation is a matter of controlling sulphur and/or air supply. The burner is gas tight, with no moving parts, and power costs are entailed only in the pump, melting pit and blower. Heat interchangers are used to cool the sulphur dioxide gases, air being the cooling medium, which air is then available for further heat interchange use.

The Leonard Construction burner does not use a spray for sulphur dispersion and this feature has occasioned perhaps more difference of opinion than any other burner development. When a spray is employed, the small bore tip of the sulphur gun does clog easily when any foreign matter enters the sulphur stream, and unless the bore is case hardened or treated in some other manner to make its surface equally tough, erosion soon destroys its effectiveness. If, however, the suction end of the pump is well screened and the sulphur of such purity as not to clog the screen, then the spray remains the efficient tool it is designed to be.

From the writer's experience, the solution of the clogging question seems to depend largely upon the sulphur supply and storage. If the sulphur charged to the pit is dumped in large enough quantities to last several hours, the pit, as a settling tank, loses much of its effectiveness and the screen trap soon plugs. If the sulphur is stored outdoors and rests on earth or cinders, many particles of foreign matter are shoveled into the pit along with the sulphur. If, however, the sulphur storage is well housed and rests on concrete, and if the charges to the melting pit are made regularly, then the pit acts well as a settling tank and a fine enough screen trap may be used about the suction end of the pump to protect the tip, and clogging occurs but rarely. In fact, these last two types of burner are both efficient sulphur furnaces and the choice between them rests largely on which one dovetails best with existing plant conditions.

Future Developments

From the foregoing discussion, several tendencies will be observed. Burners have steadily decreased in cubic space occupied; temperatures maintained in the burners have steadily increased; gas regulation has been simplified and concentration variation reduced to within very close limits; burner operation has been simplified; burner construction has become sturdier, thus decreasing repair costs; moisture and sulphur trioxide content of the burner gases have been decreased to a minimum; the necessity of burner cleaning has been appreciably lessened; and the vaporization of the sulphur feed is becoming as nearly as possible instantaneous. The large melting pit seems to have come to stay as it provides an excellent settling tank. Complete dehydration of the combustion air entering the burner is becoming a standard feature for two reasons: first, more contact plants are being located in settled districts, which necessitates the elimination of sulphuric acid mists, and second, there are large economies involved when the power supplied by the heat of sulphur oxidation may be utilized and this is most easily accomplished by using dehydrated sulphur dioxide gas, which is not corrosive.

The trend toward future improvements in sulphur burners seems to be definitely directed toward economies of operation. Power requirements will be lessened and the burner itself will become more compact, with more emphasis concentrated on its status as a heat-producing engine. What other changes will come, will be dictated largely by corresponding changes in converter and absorption equipment design.

Low Cost Attained in Electric Firing of Ceramics

Editor's Note—The following abstract, prepared by R. E. Gould, is taken from the German publication, Keramische Rundschau, from the issue of January 10, 1935. The author, H. Masukowitz, of Berlin-Neubabelsberg, is an electrical engineer who has recently been investigating the use of electric power for heating purposes for the German government. The research which he discusses is one of great interest both to the European and to American ceramic industries. Electric firing of ceramic products is now being actively investigated in the United States and it is hoped that the results of certain of these investigations will shortly be available for publication.

FOR A NUMBER of years the ceramic industry has been considerably interested in the use of electrical heat for burning the ware. Porcelain, semi-porcelain and pottery have all been successfully burned at temperatures from 1,200 to 1,400 deg. C., mosaic and wall tile at temperatures of 1,200 to 1,300 deg. C. and roofing tile at 900 to 1,000 deg. C. Such firing has generally shown an improvement in quality and a lower loss. Furthermore, marked decreases in burning time can usually be effected. In comparison with the electric kiln, the periodic kiln using coal or gas as a fuel for the burning of porcelain shows long burning time, low heat efficiency, high costs due to the destruction of saggers, high labor costs and high spoilage.

The author of this paper investigated the results of electric firing in a small laboratory kiln and found his results comparable with similar tests made in Holland. As a result of his success, he constructed a larger kiln which had substantially the cross section of a commereial tunnel kiln. Heating was accomplished by means of six 8-kw. water-cooled, vertical Globars on each side which, it was found, required careful placing since the heating of the crown and kiln bottom is impractical in tunnel kiln design. In spite of this limitation, the author found a maximum temperature difference of only 10 deg. C. within the charge and a difference of 20-30 deg. C. as the maximum throughout the kiln.

As a refractory the best grade of sillimanite was employed for the kiln walls. The Globar elements were protected with thin Carborundum plates. Adequate insulation consisting of approximately 20 in. of powdered Rieselguhr was placed in direct contact with the refractory plates. The kiln car was topped with approximately 20 in. of light insulating brick instead of the usual heavy refractory block. Above the insulating brick, over a 4¾-in. air space, were placed 1-in. SiC plates to hold the ware.

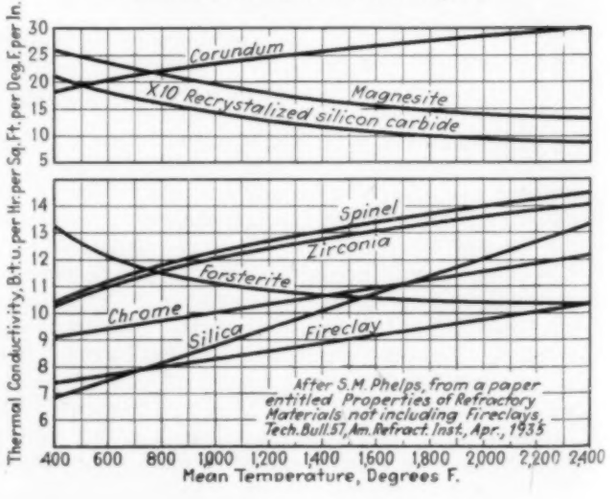
After a number of trials it was found possible to burn porcelain very satisfactorily in this kiln, requiring 5½ hours to reach 1,000 deg. C., 4 hours additionally to proceed from 1,000 to 1,100 deg. C. and 3 hours more from 1,100 to 1,350 deg. C. It was found necessary to hold the temperature at 1,350 deg. for 1 or 2 hours in order to soak the ware. A reducing gas containing 6 per cent CO was introduced from low red heat up until the time when the glaze fused at about 1,100 deg., in order to avoid discoloration of the ware. It was determined that a ware loading of about 5 to 9 lb. per cu. ft. of kiln space was possible with ordinary porcelain.

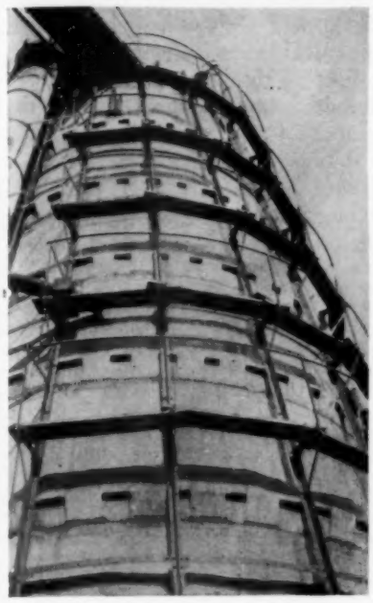
Basing his argument on the results of these tests, the author then went on to consider the effect of applying electric heating to a practical continuous tunnel kiln. He concluded that equally good results would be obtained, since in the tunnel kiln the temperature would remain constant in various zones and automatic temperature control would be possible. He concluded also that it would be practical to use a smaller cross section and recuperative tunnels, with counter-flow principles, or to place one tunnel over the other. In such a kiln the ware could be put through the tunnel on slabs. The kiln would be entirely inclosed, heated all over and the ratio of ware to refractory material would be more favorable.

Concerning the life of various sorts of heating element, the author concludes that the Globar element is the most satisfactory, having a life of about 1,500 hours in a reducing atmosphere and of about 2,000 hours in an oxidizing atmosphere. For lower temperature firing, ordinary chrome-nickel elements are satisfactory to 1,100-1,150 deg. C. Certain special alloys of iron, chromium and aluminum, with additions of cobalt, withstand temperatures to 1,400 deg. C.

The author determined, on the basis of his experimental results, the heat balance for a tunnel kiln for burning porcelain at the rate of 4,400 lb. of ware per 24 hr. This kiln would have a total connected load of 300 kw., distributed between chrome-nickel and Globar elements. The power consumption would be in the neighborhood of 3,000 kw.-hr. per short ton, and the thermal efficiency, 11 per cent. On the other hand, should a recuperative two-track tunnel kiln employing countercurrent principles be used, a production of 8,800 lb. per 24 hours would be obtained, at a power consumption of 1,330 kw.-hr. per short ton and at a thermal efficiency of 25 per cent based on the net weight of ware. Other calculations on operating costs of such a recuperative kiln, in comparison with double-deck round periodic kilns, using coal for fuel, showed figures considerably in favor of the electric firing.

The chart below, taken from a recent technical bulletin of the American Refractories Institute, assembles and averages the more authoritative data on thermal conductivities of refractories obtained in recent years





Mills-Packard chamber, looking up

Operating a Mills-Packard Plant Under Tropical Conditions

By P. J. GLEESON

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IN THE metallurgical treatment of zinc silicate ores for the electrolytic deposition of zinc, it is necessary to deal with comparatively large tonnages of residues. These residues contain an appreciable percentage of soluble and insoluble sulphates, and as no zinc sulphate comes forward with the ore, it is necessary to add sufficient make-up sulphuric acid to cover losses.

After careful consideration, the Rhodesia Broken Hill Development Co. decided to erect a modern Mills-Packard chamber system at its Broken Hill, Northern Rhodesia, plant for manufacturing the company's requirements of acid. The plant was originally designed for a production of 45,000 lb. of 100 per cent equivalent H_2SO_4 daily, using SO_2 derived from the roasting of zinc blende concentrates. The equipment included two 12-ft. i.d., nine-hearth Herreshoff-type furnaces; one 12-by-32-ft. Glover tower; four 14,600-cu.ft. Mills-Packard reaction chambers which, with flues, totaled 60,000 cu.ft. chamber space; two 13-by-45-ft. series Gay Lussac towers; a 1-ton nitric acid retort with Ionac S-pipe condenser system; and other necessary equipment, such as circulating and storage tanks and pumps. Operating characteristics of this set-up are indicated in Table I.

Following a decision to increase zinc production, it was necessary to provide for increased acid production,

Table I—Operating Characteristics With Two Furnaces on Zinc Blende and Four Mills-Packard Chambers

(Terms: B.O.V., Glover tower acid; C.O.V., chamber acid; W.N.V. and S.N.V., weak and strong nitrous vitriol)

	Temperature, Deg. C.	Degrees Tw.	Per Cent HNO_3
No. 1 chamber	65–70	110–115	Nil
No. 2 chamber	.....	110–120	Nil
No. 3 chamber	.....	100–105	Nil
No. 4 chamber	30–35	85–100	0.2
B.O.V. ex coolers	40	136–138	Trace
W.N.V.	.....	136–138	0.3–0.5
S.N.V.	.....	136–138	0.9–1.0

Production = 45,000 lb. H_2SO_4 daily
Nitre consumption = 5 per cent $NaNO_3$
Glover packed space = 1 cu.ft. per 6.8 lb. S per 24 hours
Gay-Lussac packed space = 1 cu.ft. per 1.9 lb. S per 24 hours
Cubic feet chamber space per 1 lb. S per 24 hours = 4.5

Table II—Operating Characteristics With Two Furnaces on Zinc Blende, One Sulphur Burner and Six Mills-Packard Chambers

	Temperature, Deg. C.	Degrees Tw.	Per Cent HNO_3
No. 1 chamber	75–80	110–115	Nil
No. 2 chamber	.....	120–125	Trace
No. 3 chamber	.....	115–120	Nil
No. 4 chamber	.....	110–115	Nil
No. 5 chamber	.....	100–105	Trace
No. 6 chamber	33–40	90– 95	0.2
B.O.V. ex coolers	40–42	138–140	Trace
W.N.V.	.....	.....	0.3–0.5
S.N.V.	.....	.....	0.9–1.1

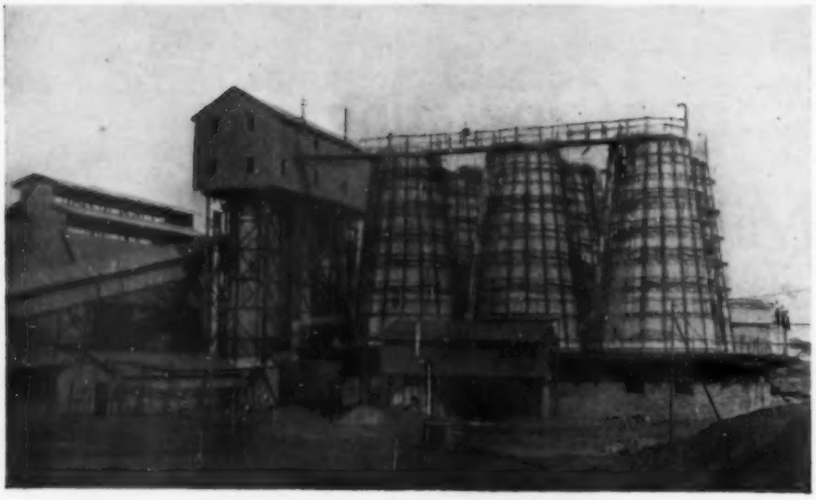
Production = 65,000 lb. H_2SO_4 daily
Nitre consumption = 6.5 per cent $NaNO_3$
Glover packed space = 1 cu.ft. per 10.0 lb. S per 24 hours
Gay-Lussac packed space = 1 cu.ft. per 2.8 lb. S per 24 hours
Cubic feet chamber space per 1 lb. S per 24 hours = 4.1

and this was done by adding two extra Mills-Packard chambers, in series, to the above plant. No extra provision was made for Glover or Gay-Lussac space, but extra circulating pumps were supplied in order to increase the tonnage of circulated acid. The plant was then estimated to have a capacity of 65,000 lb. of H_2SO_4 (100 per cent) daily. In order to supply sufficient SO_2 for this production one "Prentice" sulphur burner, capable of burning 500 lb. of sulphur per hour, was connected to the main SO_2 flue system. (See Table II.)

At this period a small ammonia oxidation plant was erected partially to replace the use of nitric acid in supplying fresh nitrogen oxides to the process.

Supplies of zinc blende gradually became exhausted as the company ceased treating its deposits of lead-zinc sulphides, and the plant was slightly altered to handle iron pyrite obtained from Southern Rhodesia. The burning of brimstone was then stopped, since the two Herreshoff furnaces had ample capacity, while roasting pyrite, for the production of the required tonnage of acid. Table III shows the results attained.

Toward the end of 1933 the company entered into a contract to supply 200 short tons of H_2SO_4 per month to the Rhokana Corp., and in order once more to increase production, it was decided to erect a third furnace, add



General view of Mills-Packard acid plant

extra acid coolers, and eventually to install turbo-dispersers in the first four reaction chambers.

After the third furnace was brought into operation, acid production was raised to 80,000-90,000 lb. of H_2SO_4 (100 per cent) daily, but this, as can be imagined, was at the expense of heavy nitre consumption. The plant worked smoothly on this high production but, because of the small Glover and Gay-Lussac capacity, and the increased temperature of the circulating acids, the nitre consumption averaged around 7.5 per cent $NaNO_3$. (See Table IV.)

When turbo-dispersers have been installed and extra acid coolers are in operation, it is expected that the present production can be maintained with a lower nitre loss, or that extra production can be made with approximately the present percentage of nitre loss.

Should the present high production be maintained for a considerable time in the future, it may be necessary to increase the Gay-Lussac capacity in order to decrease nitre losses. The matter will be a question of economics where the extra cost of sodium nitrate over a given time is balanced against the capital cost of the erection of a third Gay-Lussac tower.

The main point to be noted is that, even under adverse climatic conditions, high initial temperature of cooling water (28 deg. C.), and insufficient capacity for both Glover and Gay-Lussac towers, the Mills-Packard system is capable of being pushed to high acid production figures.

One of the principal troubles in connection with production of acid at Broken Hill is the high initial temperature of the cooling water. This makes the question of heat transfer a major problem.

As previously mentioned, additional acid coolers are to be installed, and as these are of extra large construction, it is assumed that the temperature of the circulating acids will be brought to within reasonable limits. At the same time, it has been decided to draw water (for cooling acids and chambers) from another source, which will supply water at 24 deg. rather than 28 deg. C. as at present used.

Brief details of various sections of the plant are as follows:

Roasting Section—The iron pyrite is railed 1,006 miles from the company's property in Southern Rhodesia and assays approximately 40 per cent S. It is first crushed in a 9 by 16-in. Blake Marsden crusher and ground through a No. 3 Krupp mill to pass ⅛-in. mesh. The ground pyrite is then mixed with 10 per cent, by weight, of burned cinders in order to reduce the sulphur content and at the same time supply Fe_2O_3 which has the property of preventing caking during the first intense oxidation of the FeS_2 to $FeS + SO_2$. This mixture is elevated to the individual storage bins and finally fed to the furnaces by means of adjustable screw-feed arrangements.

There are three furnaces, each having nine superimposed hearths of 12-ft. internal diameter with a slope of 5 in. from center to circumference. The burned cinders discharge through dust seals and join a common 12-in. conveyor which transports the material for final dumping. There is one chrome-nickel steel rabble arm per hearth (teeth cast on arm) driven by means of a 16-in. diameter cast-iron column, lagged with 1¼-in. firebrick tile, at approximately 1 r.p.m. An exhaust fan system draws cold air through the hollow column but the arms are uncooled.

Table III—Operating Characteristics With Two Furnaces on 40 Per Cent Pyrites, and Six Mills-Packard Chambers

	Temperature, Deg. C	Degrees Tw.	Per Cent HNO_3
No. 1 chamber	75–80	110–115	Nil
No. 2 chamber	.....	120–130	Trace
No. 3 chamber	.....	120–125	Trace
No. 4 chamber	.....	105–115	Nil
No. 5 chamber	.....	100–110	Trace
No. 6 chamber	35–42	85–95	0.3
B.O.V. ex coolers	40–42	138–140	Trace
W.N.V.	.....	.....	0.4–0.6
S.N.V.	.....	.....	1.0–1.2

Production = 72,000 lb. H_2SO_4 daily
Nitre consumption = 7.0 per cent $NaNO_3$
Glover packed space = 1 cu.ft. per 12.0 lb. S per 24 hours
Gay-Lussac packed space = 1 cu.ft. per 3.0 lb. S per 24 hours
Cubic feet chamber space per 1 lb. S per 24 hours = 3.7

Top of the chambers from the feed-tank house

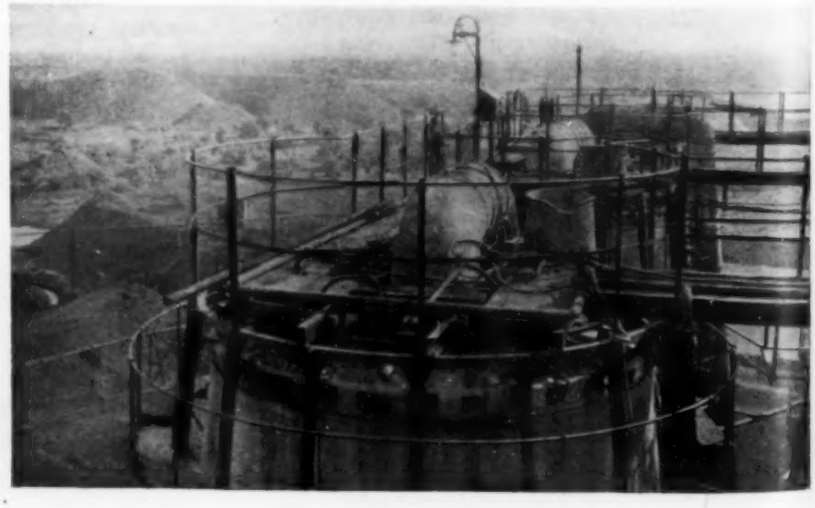


Table IV—Operating Characteristics With Three Furnaces on 40 Per Cent Pyrites, and Six Mills-Packard Chambers

	Temperature, Deg. C	Degrees Tw.	Per Cent HNO_3	Acid Make, Lb. H_2SO_4 Per Day	Gases Entering Chamber, Deg. C.	Acid in Chamber, Deg. C	Cooling Water Ex Chamber, Deg. C
Glover tower	.....	.....	.....	14,000	..	..	..
No. 1 chamber	80–85	110–120	Nil	9,000	76	65	36
No. 2 chamber	.....	120–130	Trace	15,000	86	68	37
No. 3 chamber	.....	120–125	Nil	18,000	80	69	37
No. 4 chamber	.....	110–120	Nil	17,000	70	61	35
No. 5 chamber	.....	103–110	Trace	9,000	65	41	33
No. 6 chamber	.....	90–100	0.4	3,000	53	39	31
B.O.V. ex coolers	40–50	139–141	Trace	.....	..	..	..
W. N. V.	.....	.....	0.5–0.7	.....	..	..	..
S. N. V.	.....	.....	1.3–1.6	.....	..	..	..

Production = 85,000 lb. H_2SO_4 daily
Nitre consumption = 7.5 per cent $NaNO_3$

Initial temperature cooling water to plant = 28 deg. C.
Mean temperature of water ex chambers and coolers = 35 deg. C.

Glover packed space = 1 cu. ft. per 13.0 lb. S per 24 hours
Gay-Lussac packed space = 1 cu.ft. per 3.6 lb. S per 24 hours
Cubic feet chamber space per 1 lb. S per 24 hours = 3.2

The SO_2 gases leave each furnace through two 30-in. diameter cast-iron goose-necks which join a common 30-in. diameter C.I. manifold. A torpedo, worked by ⅜ M.S. chain on hand winches, is used to keep the manifold clear of settled flue dust. From the manifold the remainder of the flue system is 30-in. diameter and made from Armco sheet iron.

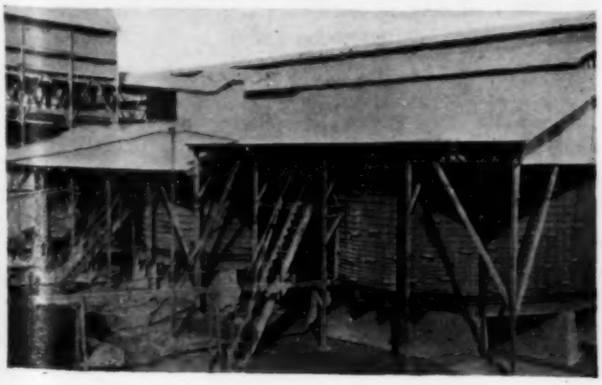
All flues are lagged with a 2-in. thickness of asbestos around which flat galvanized iron is fitted, to protect the lagging from heavy rains. One plate-steel Sturtevant hot-gas fan, running at 1,200 r.p.m. draws the SO_2 gases from the furnaces and delivers them to the Glover tower at about 7 per cent SO_2 and 450 deg. C.

All flues are built on the inverted V construction plan to prevent settling out of dust.

Glover Tower—The tower proper sits in a saucer 18 in. high, formed from 60-lb. lead. The entrance pipe is of cast iron, lead covered and lined with acid- and fireproof tile. Special shaped red acidproof brick are used for the tower lining and the packing is of cylindrical and ribbed packing pieces. The entablature and packing occupies 28 ft. of the tower height, and gives a total volume of 2,200 cu.ft. packed space.

As very little dust is separated from the gases before entering the Glover, there is a heavy accumulation of sludge in the tower. For this reason the tower is flushed every second day and a plug outlet in the bottom of the saucer allows the dislodged solids to be dropped into a sump from which they are pumped to the leach plant storage tanks.

Above: Tower feed-tank building
Below: Lead-lined acid storage tanks



Gay Lussacs—Each tower has a packed space of 3,900 cu.ft. including the entablature, making in all 7,800 cu.ft. of packed Gay-Lussac space. Propeller packing followed by ribbed packing is used, and has given excellent service.

Pumps and Tanks—Standard single-leg Ferraris pumps are used for pumping the circulating acid to the top acid storage tanks. Each pump has a capacity of 500 g.p.h. and there are two pumps for each tower. A spare pump serves to handle C.O.V. and can also be used on any particular acid in case another pump is out for repairs. Pumping capacity allows for the circulation of up to 200 tons per day through each tower.

Generally speaking, the Ferraris pumps have given excellent service, the only disadvantage being that, with a large amount of solids in the circulating acids, settlement takes place in the pump bowls, making it necessary frequently to dismantle the pump for cleaning.

Top and bottom acid storage tanks are of sufficient capacity to enable the plant to be operated for approximately 2 hours in the event of the pumps failing.

Acid is fed to all towers by means of flushing sprays. Each tower is fitted with three sprays which are in turn fed from syphon boxes.

Mills-Packard Chambers—These are standard 15,000-cu.ft. chambers and are built of 8-lb. lead. Monarch sprays (1 mm. orifice) supply water for the reaction. A three-throw pump fitted with sponge filters supplies clean water at 80 lb. per square inch to the sprays, while centrifugal pumps deliver cooling water to the top distributing launders of each chamber. The cooling water used is almost saturated with lime carbonates, which at one time caused considerable trouble owing to formation of scale on the lead walls. This was overcome by using a little salt cake (from the nitric acid section) in the water gutters on the chamber tops.

Ammonia Oxidation—Ammonia is shipped from Europe in cylinders containing 500 lb. NH_3. The cylinders are connected, through a reducing valve, to a small gasometer which is designed to hold a reserve of 30 minutes' supply and also keep the NH_3 gas at a constant pressure of around 12 in. water gage. From the gasometer the NH_3 gas passes through a small-diameter pipe which is connected to the air supply by means of a Y piece. The air-ammonia mixture is regulated by means of differential gage readings, to give an air-ammonia ratio of 9:1. After passing through a glass-wool filter the mixture enters the converters.

The oxidation unit consists of three preheated-type converters in parallel, each fitted with a platinum-rhodium catalyst gauze of 6 by 4 in. exposed area. The capacity of each converter is approximately equivalent to 500 lb. of HNO_3 per 24 hours.

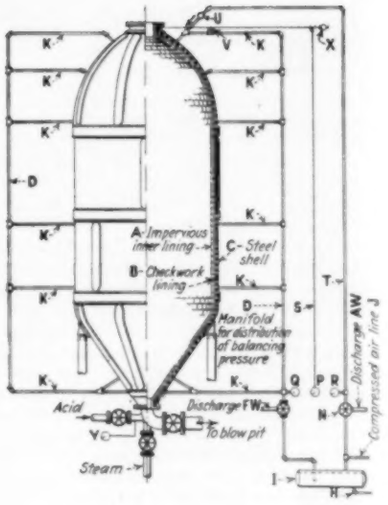
Nitric Acid Section—Following the installation of the ammonia oxidation section, this plant was used mainly as a standby. However, owing to the increasing cost of ammonia, a certain proportion of the nitrogen oxide requirements is supplied by means of nitric acid. The plant consists of a 1- ton-capacity retort connected to a 6-in. diameter Ionac S-pipe condenser system. The condenser is connected to Ionac receivers from which the condensed HNO_3 is run into large earthenware storage tanks, each of 200 gal. capacity.

A 2,000-lb. charge of sodium nitrate takes about 10 to 12 hours to finish and yields 70 per cent HNO_3 with a 95 per cent recovery. No absorption tower is used on the end of the condenser system.

Cleaning Arrangements—All chambers, towers and tanks are fitted with bottom sludge outlets which are operated by means of plugs. Cleanings discharge into a common sump and are pumped to the zinc leach plant storage tanks. Cleaning of any part of the acid system is, therefore, rendered easy and efficient.

Preventing Seepage Through Linings

By H. E. KIP and L. M. CURRIE
National Carbon Co.
Cleveland, Ohio



By use of a pressure balancing system, seepage through the tank lining to the outer container can be avoided

MANY PROCESSES in the chemical industry require the use of vessels in which an inner lining of protective material is necessary to prevent the corrosion of the outside metal container. Brick or tile made of ceramic, carbon or other non-corrosive material is generally used for the lining.

Extreme care is required in selecting the proper material for linings and considerable attention is given to the method of installation. Even though every precaution may be taken with the original installation, there are many unforeseen factors that will have a bearing on the proper functioning of the lining.

Common causes of lining failures may be credited to seepage through more or less porous lining materials, leakage through cracks due to wide variations in temperature, and leakage through porous bonding materials. A common source of trouble and expense is the failure of the inner lining due to the chemical action of the bath or treating fluid. The use of materials such as impervious carbon brick or tile has helped materially in obviating this difficulty. Seepage through the tank lining to the outer container can generally be attributed to the pressure gradient which exists between the treating liquor and that part of the lining adjacent to the shell due to some degree of porosity of the lining and to cracks that may tend to form during the operation of the equipment.

A method of neutralizing or balancing this pressure gradient is shown in the accompanying illustration. It is accomplished by means of an open checker-work lining made to support the inner lining of the vessel. While the illustration shown is that of a pulp digester, the same principle can be applied to other types of containers. It will be observed that the inner lining, *A*, is supported by the checker-work lining, *B*, which is adjacent to the inner wall of the main container.

By introducing a fluid into the voids in the checker work, a back pressure can be created on the back of the lining which will equalize the pressure of the treating fluid on the inner face of the lining, thereby preventing any flow of the treating liquid through the lining. The pressure of the fluid in the voids of the checker work, *B*, may be accurately regulated to balance the pressure or it may be regulated at the will of the operator to be greater or less than that pressure by such predetermined amount as may be desired under operating conditions.

An arrangement of supply pipes, valves, and gages is shown in the illustration, which will enable the operator to follow a varying pressure in the treating fluid with corresponding adjustments in pressure on the balancing fluid. This part of the operation may be manual or automatic control. Balanced regulation may also be accomplished by opening valve *V* thus applying the pressure developed by the gas within the digester directly to the balancing fluid in the checker voids.

It will be noted that a pressure supply tank, *I*, fed by supply line, *H*, is the method used for supplying the balancing fluid. The fluid is carried through several vertical manifold header pipes, *D*, spaced equidistant about the digester and connected to the shell, *C*, by taps, *K*, for delivery of the fluid to the spaces in the checker work. A compressed air line, *T*, connected to compressor line, *J*, supplied the pressure to the tank.

In the header pipe, *D*, there is a three-way regulating valve, *M*, a pressure gage, *Q*, and a fluid waste line, *FW*. In the air pressure line, *T*, there is a three-way regulating valve, *N*, a pressure gage, *R*, a check valve, *U*, and an air waste pipe, *AW*. A pressure gage, *P*, connected by the pressure line, *S*, to the top of the digester shows at all times the gas pressure at the top of the digester. The gas line, *S*, has a relief valve, *X*.

Another method of balancing the pressure is by the use of compressed air supplied through the lines *J* and *T* to the spaces in the checker-work lining at the top of the digester. This pressure can be governed at the valve, *N*, to equalize the pressures shown on gages *P* and *R*.

The use of such a pressure balancing system offers added advantages by selecting various balancing fluids containing materials which react chemically with the treating fluid. In the case of a digester, this balancing fluid can be so chosen as to form a neutral substance which should not react further with the liquor or be soluble in the balancing fluid. This neutral substance would tend to plug the capillary tubes and cracks, thus preventing or retarding seepage through the lining.

As an illustration of solutions which might prove satisfactory for use in the balancing fluids for digesters, cookers, tanks, and the like, a list of typical examples of possible combinations is given.

Type of Cooker	Type of Digester Liquor	Possible Balancing Fluid
Alkaline pulp	Caustic	Alum solution, chrome alum solution or inhibited solutions of ferric salts
Neutral pulp	Sulphate solutions	Suspension of lime in barium chloride solution
Acid pulp	Acid solutions	Sodium silicate plus an introfier

Combinations giving a flocculent or gelatinous precipitate are probably preferable as they should give a maximum plugging effect with minimum expansion and spalling action. In any event, the most desirable combination will depend upon the composition of the liquors in the digester body and should be selected accordingly.

FERROUS AND NON-FERROUS ALLOYS

CLASSIFIED BY COMPOSITION

A supplement to Chem. & Met.'s 1934-35 Directory of Corrosion Resistant Materials

Arranged by Max A. Shaffer
Cumberland, Md.

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CHROME NICKEL IRON ALLOYS

	Cr	Ni	C	Misc.
Adamite	1.0	0.75		
Circle L-12	13	0.50 max.	0.10	
Circle L-13	13	0.50 max.	0.35	
Carpenter St. N1	13	2	0.10	
Defirust	12–15	0.50 max.	0.10 max.	Mn, 0.25–0.6
Bethadur 1	12–15	0.50 max.	0.12 max.	
Bethadur 6	12–15	0.50 max.	0.30–0.40	
Silcrome 12–2	12–15	1.25–2	0.12 max.	
Calduro 13–2	12.5–15	1.50–2.50	0.20 min.	
Colonial 410	13.5	1	0.12 max.	
Colonial 410F	13.5	1	0.12 max.	S, 0.25
Defirust Special	15–18	0.50 max.	0.10 max.	Mn, 0.25–0.6
Bethadur 7	16–18	0.50 max.	0.60–0.70	
Bethadur 4	16–18	0.50 max.	0.12 max.	
Bethadur 8	16–18	0.50 max.	1.10–1.20	
Tisco 102	16.5–20	7–10.5	0.07 max.	Si, 2.0 max.; Mn, 1.0 max.
Tisco 103	16.5–20	7–10.5	0.20 max.	Si, 2.0 max.; Mn, 1.0 max.
Colonial 610	17	1	0.12 max.	
Colonial 610 F	17	1	0.12 max.	S, 0.25
Colonial 795	17.25	1	0.95	
Caloxo 18–2	15–20	1.50–2.50	0.20 min.	
Defistain Mchg	18	8		
Duraloy 18–8	18	8		
Calite E	18	8		
Genesee KA2	18	8		
Misco 18–8	18	8		
Par 5	18	8		
KA2	18	8		
Sterl. Nirosta 19–9	18 min.	8 min.		
Stainless 18–8	18	8		
Uniloy 18–8	18	8		
49 Alloy	18	8		
Dureo KA–2S	18	8	0.07 max.	
Sweetaloy 17S	18	8	<0.10	
B & W 600	18	8	0.10	
Defistain	18	8	0.11 max.	
Timkin 18–8S	18	8	0.11 max.	
Empire 18–8	18	8	0.15	
Resistal KA2	18	8	0.15 max.	Mn, 0.65
Resistal 2C	18	8	0.15 max.	Si, 2.25
Timkin 18–8	18	8	0.08–0.20	
Silcrome KA2	18	8	0.09–0.20	
Silcrome KA2-EZ	18	8	0.20 max.	
Sweetaloy 17	18	8	<0.20	Si, 0.50; Mn, 0.5
USS 19–9	18	8	0.20	
Fahrite N2	18	8	0.15–0.25	Mn, 0.50
Nationalloy 1	18 min.	8 min.	0.40 max.	
Bethadur 2	17–19	7–9	>0.08	
Bethadur 2A	17–19	7–9	0.08 max.	
Sterl. Nirosta KA2	17–19	7–9	0.08–0.20	
Sterl. Nirosta KA2S	17–19	7–9	0.11 max.	
Allegheny Metal A	17–19	7–9	0.11 max.	
Sterl. Nirosta KA2	17–19	7–9	0.08–0.20	
Allegheny Metal C	17–19	7–9	0.08–0.20	

CHROME NICKEL IRON ALLOYS

	Cr	Ni	C	Misc.
Allegheny Free Mchg	17–19	7–9	0.08–0.20	S, 0.30
Carpenter St. 4	18	9	0.10	
Midvaloy 18–8	18	9	C	
High Gloss F. Mchg	17.5–19	7.5–9		P, 0.13–0.16
Sivyer 60	18.5	9	0.10	
Stainless N	18.5	9	0.12 max.	
Lesco 18–8–8	17–20	7–10	0.07 max.	
Calmar 18–8	17–20	7–10	0.16 min.	
Lesco 18–8	17–20	7–10	0.20 max.	
Armco 18–8	17–20	8–10	0.08 & 0.2 max.	
USS 18–8S	17–20	8–12	0.07	
USS 18–8	17–20	8–12	0.15	
Enduro AA	18–20	8–10		
Q Alloy Cr. CN2	18–20	8–10		
Bethadur 2C	18–20	8–10	0.08 max.	
Bethadur 2B	18–20	8–10	0.08 min.	
Milwaloy 26	18–20	8–10	0.08–0.12	
Allegheny Metal B	18–20	8–10	0.08–0.20	Mn
Defistain	18–20	8–10	0.08–0.20	0.25–0.6
NA 4	18–20	8–10	0.30 max.	
Circle L-22	19	9	0.07 max.	
Defistain, Special	19	9	0.11 max.	
Timkin 19–9S	19	9	0.11 max	
Circle L23	19	9	0.15	
Timkin 19–9	19	9	0.08–0.20	
Defistain Special	19	9	0.08–0.20	
USS 20–10	19	9	0.20	
Amsco Alloy F8	18–21	8–11		
Bethadur 2E	19–21	9–11	0.08 max.	
Bethadur 2D	19–21	9–11	0.08 min.	
Allegheny 22 Special	19–22	9–12	0.11 max.	
Allegheny 22	19–22	9–12	0.08–0.20	
Enduro 20–10	19–22	9–12		
Timkin 20–10	20.5	10.5	0.08–0.20	
Timkin 20–12S	20.5	10.5	0.11 max.	
Uniloy 21–12	21	12		
Bethadur 5	20–22	0.50 max.	0.12 max.	Mn Si 0.5 max.; 0.5 max.
Enduro HC	23	0.30 max.	0.20 max.	
B & W 650	23	11	0.19	
Chromel 670	22–24	10–12		
Fahrite N8	20–26	18–20		
Silcrome 25–12	22–25	10–13	0.20 max.	Mn
Fahrite N3	24	9	0.20–1.0	0.35–0.75
Midvaloy 25–10	24	11		
Misco B	24	12		
Uniloy 24–11	24	12		
Empire 24–12	24	12	0.25	
Sivyer 62	24.5	12.5	0.18	
Bethadur 9	24–26	0.50 max.	0.30 max.	
Par 4	25	2		
Calite B28	24–26	8–10		
B & W 830	25	11	1.25	
Rustless Iron 25–12	25	12		Si
Resistal 3	25	12	0.20 max.	2.25
100 Alloy	25	12	0.50 max.	Mn Si 1.5 max.; 0.5 max.
Enduro HCN	24–26	11–13	0.20 max.	

CHROME NICKEL IRON ALLOYS

	Cr	Ni	C	Misc.
Lesco 25-12	24-26	11-13	0.20 max.	
Allegheny 44	24-26	11-13	0.20 max.	
Q Alloy Cr. CN1	24-26	11-13		
USS 25-12	22-28	12-16	0.25	
Calite NCT3	25	18		
Caloxo 25-20	23-27	17-21	0.20 min.	
Midvaloy 25-20	25	19.5	0.12	
Genesee 333	25	20		
Resistal 7	25	20	0.15 max.	Si, 1.0
Allegheny 2520	24-26	19-21	0.25 max.	
B & W 1100	25	21	0.25	
Silcrome 25-20	24-27	18-21	0.25 max.	
Sweetaloy 22	24-28	10	0.50 max.	Si, 0.5; Mn, 0.5
Duraloy N	24-28	10-12		
Durco 26-12	26	12		
Midvaloy 26-02	26.5	1.5	0.25	
Cimet	27	11		
Heat Resisting 5	25-29	12-14		
Amsco Alloy F3	26-29	0-3		
Caloxo 26-4	25-30	2.5-4	0.25 min.	
Amsco Alloy F10	26-29	10-13		
Tisco 107	26-30	8-12	0.30 max.	Mn, 1.0 max.; Si, 0.5-1.5
Empire 25-5	28	2	2	
B & W 1500	28	8	0.25	
48 Alloy	28	8	0.50 max.	
Genesee 280	28	10		
Par 6	28	10		
NA 1	27-29	9-11	0.30 max.	
Circle L31	28	11	0.25	
63 Alloy	28	15		
Circle L15	28.5	0.50 max.	0.30	
Caloxo 28-10	27-30	8-12	0.25 min.	
Milwaloy 38	28-30	8-10	0.12-0.15	
Misco C	29	9	0.25	Mn, 0.6
Sivyer 64	29.5	9.5	0.25	
Durco 30-15	30	15		
Pyrrasteel	26-39	10 max.		
Misco 30-30	30	30		
Empire 35-15	35	15	0.35	
Empire 60-20	60	20	0.50	

NICKEL CHROME IRON ALLOYS

	Ni	Cr	C	Misc.
Genesee 315	3	1.5		
Genesee Ni-Hard	4.5	2		
Nationalloy 2	18 min.	6 min.	0.50 max.	
Bethadur 3	17-19	8-10	0.15 max.	S P Mn
Caloxo 818	17-20	7-10	0.16 min.	
Cyclops 17	20	8		
Circle L24	20	9	0.15	Mn
Fahrite N4	20	10	0.40	0.5-0.75
Verialoy	20	10		
Misco N	20	10		
Calite B	21	9		
Heat Resisting 4	21-22	8-9		
Avesta 254	21.5	18.5	0.10 max.	Mn Si
Sweetaloy 18	22	10	0.25 max.	0.5; 0.5
Pyrrasteel	25	14		
Sweetaloy 21-A	25	15	0.30 max.	
Caloxo 15-25	23-27	14-17	0.20 min	Si
Resistal 4	25	18	0.20 max.	2.5
Enduro 20-25	24-26	19-21		
Tophet D	30	5		
Comet	30	5		
Economet	30	10		
Midvaloy 30-30	30	27	0.50	
Misco 30-30	30	30		Mn
Chromel 502	30-34	18-22	0.50 max.	2.0
NA 2	30-35	15-19	0.30 max.	
Milwaloy 50	32-36	15-18	0.30-0.40	
Cromin D	35	2		
Calite A	35	15		
Chromax	35	15		
Misco Metal	35	15		
Sivyer 70	35	15	0.25	
X-ite B	35	15		
Zorite	35	15	0.50 max.	
Caloxo 15-35	33-37	14-17	0.20 min.	
Circle L32	35	16	0.50	
Par 7	35	16		
Pyrrasteel	35	16		
Midvaloy 1835-A	35	18	0.35	
Midvaloy ATV1	36	11-15	0.35	Mn Si
Sweetaloy 29	36	18	0.50 max.	0.5; 0.5
Amsco Alloy F1	35-38	16-19		
Fahrite N1	38	18	0.30-1.0	0.5-1.0
X-ite	37-39	17-19		
Thermalloy B	40	20	0.40-0.60	1.5; 1.5
Fahrite N5	60	12		
Q Alloy B	60	12		
Misco HN2	60	15		
Tophet C	60	15		
Premier Nickel Cr	60-62	14-16	0.10	
Amsco Alloy F6	60-63	12-15		

NICKEL CHROME IRON ALLOYS

	Ni	Cr	C	Misc.
Amsco Alloy F5	62-65	18-21		
Fahrite N6	65	15		Mn Si
Sweetaloy 21	65	15	0.50 max.	0.5 0.5
Misco HN1	65	18	0.50	0.6
B & W 700	65	18	0.60	
Par 8	65	18		
Fire Armor	65	20	0.50 max.	
NA 65	65-70	18-20	0.30 max.	

CHROME IRON ALLOYS

	Cr	C	Misc.
Par 3	3		
Allegheny 40	4-6	0.10-0.25	
Carpenter V-Chrome	4-6	As specified	Si
Bethlehem 4-6 Chrome	4-6	0.10-0.25	0.3 max., or 1-1.35
4/6 Chrome	4-6	0.15	
Timkin 4-6 Chromium	5	0.15 max.	
Uniloy 4-6 Chrome	5	0.25 max.	
Warman 5	4-7	0.18 min.	
Stainless Steel A	8-16	0.12 min.	
Durco	12	0.10-0.12	
Allegheny 33 Turbine	11.5-13	0.12 max.	
Defirust Turbine	11.5-13		
Lesco L	11.5-13	0.10 max.	Mn Si
Lesco LS	11.5-13	0.12 max.	0.3-0.5; 0.5 max
Silcrome 12	11.5-13	0.12 max.	0.20-0.50
Silcrome 12 EZ	11.5-13	0.12 max.	0.40-0.60
Warman 13	11-14	0.12 min.	
Nationalloy 3	12-13.5	0.20 max.	
USS 12	11.5-14	0.10	
Carpenter Stainless No. 1	12-14	0.10	
Carpenter Stainless No. 2	13	0.30	
Sivyer 66	13	0.10	
Milwaloy 13	12-14	0.08-0.12	
Silcrome L12	12-14	0.30-0.40	
Sta-Gloss	12-14		Mn Si
Stainless Steel C	12-14	0.12 max.	0.40 max.; 0.4 max
Enduro S	11.5-15		
Stainless Iron 12	11.5-15	0.12 max.	
Allegheny 33	12-15	0.12 max.	S
Allegheny 33 Free Mchg.	12-15	0.12 max.	0.40 max.
Duro Gloss C1	12-15		S
Duro Gloss Free Mchg.	12-15		0.25-0.35
Lesco Reg. Stainless	13-14	0.30-0.40	Mn
Stainless A	13.5	0.35	0.35 S
Colonial FMS	13.5	0.12 max.	0.25
Stainless I	13.5	0.12 max.	
Stainless Steel A	13-14	0.25-0.35	
Stainless Steel A	12-15	0.12 min.	
Defirust Machining	12-15		
Sterling Stainless T	12-15	0.12 max.	S
Carpenter Stainless No. 5	14	0.10	0.30
Duraloy C	14		
Genesee 212	12-16	0.20 max.	
Lesco LM	13-15	0.10 max.	
Sterling Nirosta FC	14	0.12 max.	Mn
Sterling Stainless FC	14	0.10	0.40
Uniloy 1409	14	0.10	
Uniloy 1435	14	0.35	
Midvaloy 13-00	15 max.	0.12 max.	
Stainless Iron C1	15 max.	0.12 max.	
Par 10	15		
Silcrome RA-EZ	15-17	0.12 max.	Mn Si
Sweetaloy 16	14-18	0.35 max.	0.5, 0.5
Allegheny 66	15-18	0.12 max.	
Armco 17	15-18	0.12 max.	
Lesco M	15-18	0.10 max.	
Stainless B	16.5	0.65	
Stainless Iron C2	15-18	0.12 max.	
Stainless Iron 16	15-18	0.10 max.	
Stainless Steel B	16-17	0.50-0.60	
Stainless Steel B	15-18	0.55 min.	
Sterling Stainless M	15-18	0.12 max.	
Carpenter Stainless 6	17	0.10	
Carpenter Stainless 2.3	17	0.95	
Colonial C2	17	0.12 max.	S
Colonial C2F	17	0.12 max.	0.25
Duraloy B	16-18	C	
Duro Gloss C2	16-18		
Q Alloy Chrome C2	16-18		
Silcrome H-17	16-18	1.00-1.10	
Silcrome M-17	16-18	0.60-0.70	
Silcrome 17	16-18	0.12 max.	
Sivyer 67	17	0.25	
Stainless Steel B	16-18	0.12 min.	
Sterling Stainless BHH	17	1.05	
Avesta 249	17.2	0.10 max.	
Avesta 249 H	17.2	0.25 max.	
Hydo Stainless	16.5-18	0.60-0.70	
Lauterite Stainless	16.5-18	0.90-1.00	
NA-18	16-19	0.30 max.	
Sta-Gloss B	17-18		
USS 17	16-19	0.10	
B & W 900	18	0.15	
Calite S	18		

CHROME IRON ALLOYS

	Cr	C	Misc.
Caloxo 18	16–20	0.16 min.	
Dureo	18	0.10	
Empire 18	18	0.20	
Uniloy 1809	18	0.10	
Uniloy 1860	18	0.60	
Circle L11	18.5	0.25	
Allegheny 67	18–23	0.12 max.	
Lesco H	18–23	0.10 max.	
Rustless Iron 21 Cr	18–23		
Silerome 21	18–23	0.20 max.	
Sterling Stainless MG	18–23	0.35 max.	
Stainless Iron C3	18–23	0.35 max.	
Stainless Iron 18	18–23	0.10 max.	
Duro Gloss C3	20–22		
USS 21	20–24	0.10	
Pyrocast	22–30		
Allegheny 55	23–30	0.35 max.	
Chrome-Iron	25–28		Mn
Defibest	23–30	0.02 max.	0.25–0.8
Fahrite N7	25–28		
Silerome 28	23–30	0.20 max.	
Stainless Iron C4	23–30	0.35 max.	
Stainless Iron 24	23–30	0.25 max.	
Duro Gloss C 4	25–29		
Lesco HH	24–30	0.20 max.	
Caloxo 23	25–30	0.25 min.	
USS 27	25–30	0.10	
Tisco 133	26–30	0.10 max.	Si, 2.0 max.; Mn, 0.4–0.6
B & W 950	28	0.25	
Calite S–28	28		
Circle L–16	28	2.25	
Dureo	28	0.15	Mn Si
Sweetaloy 19	28	0.50 min.	0.5; 0.5
Q Alloy Chrome C1	26–30		
Uniloy 2825	28	0.25	Mn
Duraloy A	27–30	C	0.60
NA–19	28–30	0.50–0.70	
Empire 30	30	0.30	
Par 9	30		
Q Alloy Chrome C3	30 min.	2.5–3.0	
55 Alloy	33		

CHROME NICKEL IRON SPECIAL

MOLYBDENUM BEARING	Cr	Ni	C	Mo	Misc.
Genesee 405	1.00	0.75	0.45	0.30	Mn, 1.50
Chromex	1.25	0.50	0.35	0.35	
Pethalon A	12–15	0.5 max.	0.12 max.	0.4 (MoS)	
Colonial 430	13.5	1	0.35	0.60	
Durco KA2S Mo	18	8	0.07 max.	4	
B & W 640	18	8	0.10	3.5	
Sweetaloy 17 MoS	18	8	0.10 max.	2–4	
Rezistal KA2 Mo	18	8	0.15 max.	3	
Silerome KA2 M	18	8	0.20 max.	2–4	Mn, 0.6–1.1; Si, 0.75 max.; S 0.03 max.
Sweetaloy 17 Mo	18	8	0.20 max.	2–4	
Pethalon B	17–19	7–9	0.10	0.4 (MoS)	
Allegheny Metal Amo	17–19	7–9	0.11 max.	2–4	
USS 18–8 Mo	17–20	8–12	0.15	Mo; several pct.	
Calmar 18–8 M	17–20	7–10	0.16 min.	3–4.5	
NA 4M	18–20	8–10	0.30 max.	3.5–4.5	
Tisco 105	18–22	7–10.5	0.07 max.	2–4	Mn, 1.0 max.; Si, 2.0 max.
Tisco 106	18–22	7–10.5	0.20 max.	2–4	Mn, 1.0 max.; Si, 2.0 max.
111 Alloy	24	12		3.5	
Caloxo 25–20 M	23–27	17–21	0.20 min.	3–4.5	Mn
HR-5M	25	20	0.30	2.5–4	0.4
Empire D	28	16		4	
Caloxo 28–10 M	27–30	8–12	0.25 min.	3–4.5	

TITANIUM BEARING	Cr	Ni	C	Ti
Allegheny Metal A Ti	17–19	7–9	0.20 max.	4 x C
Rezistal KA2S Ti	17–20	7.5–10	0.07	5 x C
USS Stabilized 18–8	17–20	8–12	0.12	0.60
Allegheny Metal B Ti	18–20	8–10	0.20 max.	4 x C

SELENIUM BEARING	Cr	Ni	C	Se
Silerome KA2S	18	8	0.08 max.	0.20–0.30
Carpenter Stainless 8	18	9	0.10	0.25
Sweetaloy 17 Se	18	8	0.20 max.	0.25
Hi-Gloss	17.5–20	7.5–10		0.22–0.26

ALUMINUM BEARING	Cr	Ni	C	Al
Allegheny 33 Non-H	11.5–13.5	0.50 max.	0.08 max.	0.10–0.25
Allegheny Qhmaloy	12–14	0.50 max.	0.12 max.	4–4.5

COPPER BEARING	Cr	Ni	C	Cu
Circle L14	20	0.50 max.	0.30	1.00

MOLYBDENUM & COPPER BEARING	Cr	Ni	C	Mo	Cu	Si	M
Stainless U	19	9	0.12 max.	1.5	1.25		
Elconet K	24	20	0.13	2	3.5	1.25	0.3

MOLYBDENUM & SELENIUM BEARING	Cr	Ni	
Enduro 18–8	17–19	7–11	Mo, Se

NICKEL CHROME IRON SPECIAL ALLOYS

MOLYBDENUM BEARING	Ni	Cr	C	Mo	Mn
Mac Hempite	1.5–3.5	0–1.25	0.40–3.0	0–0.75	0.7–4
Genesee 460	3	1	0.60	0.30	
Caloxo 15–25 M	23–27	14–17	0.20 min.	3–4.5	
Fahrite N-6 Mo	65	15		5	

TUNGSTEN BEARING	Ni	Cr	C	W
Midvaloy ATV3	25.5	14	0.48	3.5

COPPER BEARING	Ni	Cr	C	Cu	Si
Tisco 160	12–15	1.5–2	2.5–3.5	5–7	1.25–2
Genesee Ni-Resist	13	2		6	
Rezistal 2600	22.5	9	0.30	1.25	

MOLYBDENUM & COPPER BEARING	Ni	Cr	C	Cu	Mo	Si
Durimet	23	19	0.07 max.	1.0	1.0	3

CHROME IRON SPECIAL ALLOYS

MOLYBDENUM BEARING	Cr	C	Mo	Mn
Timkin DM	1.25	0.15 max.	0.40–0.60	
Timkin DM–45	1.25	0.4–3.5	0.40–0.60	
Circle L3	1.25	0.45	0.40	1.40
Circle L4	1.25–2	0.5–3.3	0.50–1.00	1.0–1.5
Genesee 255	4–6		0.50	
B & W 440	4–6		0.50	
4/6 Cr Mo	4–6	0.15	0.40–0.65	
Silerome 46-M	4–6	0.25 max.	0.40–0.60	
Warman 5-M	4–7	0.18 min.	0.50–0.70	
Circle L-10	5	0.20	0.50	
Lesco LMS	13–15	0.12 max.	0.30–0.50	
Stainless Iron 2-FM	14–15	0.11 max.	0.55	
Silerome H17-EZ	16–18	1–1.10	0.35–0.60	0.3–0.6

TUNGSTEN BEARING	Cr	C	W
Alloy 104	4.5–6.5		0.75–1.00
Allegheny 33-W	12–15	0.12 max.	2.50–3.50
Allegheny 66-W	15–18	0.12 max.	2.50–3.50

VANADIUM BEARING	Cr	C	V
Circle L-8	1.5	0.25	0.50
Milwaloy 7	1.5–1.75	0.30–0.40	0.60–0.70

COPPER BEARING	Cr	C	Cu	Mn	P	S
USS Cor-Ten	0.50–1.5	0.10	0.3–0.5	Si, 0.5–1	0.1–0.2	0.5
Silerome RA	15–17	0.12 max.	1.00	Si, 1.00		
Carpenter Stain. No. 3	20	0.30	1.00			

ALUMINUM BEARING	Cr	Al
Feeraloy	15	5

TITANIUM BEARING	Cr	C	Ti
4/6 Cr T	4–6	0.15	0.75

TUNGSTEN AND MOLYBDENUM BEARING	Cr	
Enduro 4–6 Cr	4–6	(W, Mo)

VANADIUM AND COBALT	Cr	C	V	Co
Crocar	12	2.2	0.80	0.50

MOLYBDENUM & ALUMINUM	Cr	C	Mo	Al	Mn
Nitralloy 125–135	0.90–1.4	0.20–0.40	0.15–0.25	0.9–1.4	0.4–0.6

VANADIUM, Mo AND Co	Cr	C	Mo	V	Co
Ohio Air Die	12	1.55	0.80	0.85	0.40

HIGH MANGANESE	Cr	Mn
Hascrome 157	12	4

VANADIUM AND TUNGSTEN	Cr	W	V
Formite			

TUNGSTEN AND COBALT	Cr	W	Co
Par 1			

SPECIAL FERROUS ALLOYS

HIGH SILICON	Si	C	Mn	P	S	Mo
Tantiron	13.5	1.0	0.40	0.18	0.05	
Antaciron	14.5	0.6	0.6	0.1	0.05	
Corrosiron	14.5	0.80–1.00				
Durichlor	14.5					
Duriron	14.5	0.80	0.35			

NICKEL MOLYBDENUM	Ni	Mo	C
Circle L-6	1.75	0.25	0.18
Molymet	45	10	

NICKEL MANGANESE	Ni	Mn	C
Milwaloy 18	13–15	3.9–4.5	0.30–0.45

HIGH MANGANESE	Mn	C
Amsco Mn Steel	10–14	1.0–1.4
Genesee 412	11–14	

MOLYBDENUM MANGANESE	Mn	Mo	C
Wear Prooft MacHempite	1.25	0.35	0.45

ALUMINUM MOLYBDENUM	Al	Mo	C	Mn
Nitralloy 225 & FM225	1.0–1.5	0.6–1.0	0.25–0.35	0.40–0.70

COPPER BEARING STEEL

Armco	Fe, Cu
Cor-R-Loy	Mild steel with 0.20–0.25 Cu
Toncan	Cu, 0.4 min.; Mn, 0.05 min.; (C + Mn + P + S + Si) 0.25 max.

NICKEL CHROMIUM CAST IRONS

	Ni	Cr	C	Si	Mn	P
Ni, Cr, C.I.	1.5–1.75	0.60–0.80	3–3.4	0.9–1.75	0.50–0.7	0.3 max.
Ni-Hard	4.4–4.6	1.40–1.60	2.75–3.6	0.5–1.5	0.30–0.7	
Ni-Resist	12–15	1.50–4	2.75–3.1	1.25–2	1–1.5	Cu, 5–7
Ni-Resist Cu free	15–20	Up to 2.5	2.2–3	0.6–2	1–1.5	
Dopploy	17–20	2.5	3.0	2		

NICKEL CAST IRON

Ni-Tenayliron	Ni, 1–4

MALLEABLE IRON

	C	Si	Mn	S	P
Promal					
MEEHANITE METAL	3.0	0.5–6	0.4–2	0.05–0.12	0.05–0.1

ALUMINUM ALLOYS

	Al	Si	Cu	Mg	Cr	Mn
Cast 47	85	12.5				
Cast 356	91.5	7.0		0.30		
Cast 355	92	5.0	1.25	0.50		
Cast 43	92.6	5.0				
Cast 195	93		4.30			
Alclad 17 ST	94		4.0			0.50, Coated
Cast 214	95.3			3.80		
52 S	96			2.25	0.25	
3 S	97					1.25
53 S	97.2	0.7		1.25	0.25	
Cast 100	99					

LEAD ALLOYS

Antimonial Lead	75–100 Pb; 0–25 Sb
Chemical Lead	0.06 Cu
Tellurium Lead	0.06 Te
Acimet	Hard Lead
Amaloy	Pb, 99; Sn, 1

MAGNESIUM ALLOYS

	Mg	Al	Mn
Dowmetal	89.8–95.7	4–10	0.2–0.3

COBALT ALLOYS

	Co	Cr	W
Stellite 1	50	30	15.5
Stellite 12	60	30	8
Stellite 6	65	30	

COPPER ALLOYS

COPPER NICKEL	Cu	Ni	Al	Fe	Mn	Pb	Sn	Si	Cr	C
Advance	55	45								
Cupron	55	45								
Everbrite	60	30		3				3	3	
Davis Metal	67	25		6	1	0.8		0.3		0.2 max.
Super Nickel	70	30								
Barberite	88.5	5					5	1.5		
Nickel Al Bronze	92	4	4							

COPPER SILICON	Cu	Si	Fe	Zn	Mn	Sn
PMG Metal	93	3.5	1.5			
Herculoy	95.25	3.25		1		0.50
Everdur A	95	3			1	
Olympic Bronze	95.25	3		0.75		
Everdur B	98.25	1.5			0.25	

COPPER TIN	Cu	Sn	P	Si
Phosphor Bronze D	90	10		
Omega Phos. Bronze 10%	90	10	P	
Omega Phosphor Bronze B	91.85	8	0.15	
Phosphor Bronze C	92	8	P	
Phosphor Bronze A	95	5	P	
Omega Phos. Bronze A	95.5	4.3	0.20	
Duronze	97	2		1
Corvic Bronze	98.5	1.5		

COPPER ZINC	Cu	Zn	Al	Fe	Ni	Mn	Pb	Sn
Tobin Bronze	60	39.25						0.75
Hytensl Bronze	63	23	4	3		3		
Superstrength Bronze	63	27	6	3		1		
High Brass	67	33						
Aleunio G	70	27	2		1			
Admiralty	70	29						1
Red Brass	85	15						
Hardware Bronze	89	9					2	
Commercial Bronze	90	10						

COPPER ZINC NICKEL	Cu	Ni	Zn
Nickel Silver, 18% B	55	18	27
Nickel Silver 18% A	65	18	17
Ambrac A	75	20	5

COPPER LEAD TIN	Cu	Pb	Sn	Zn
Cu-Lead-Ite	50–65	27–50	2–8	
Anti Acid Metal	75	15	10	
Free Cut. Phos. Bronze	88	4	4	4

COPPER ALUMINUM IRON	Cu	Al	Fe
Ampco 18	84.75	11.4	3.8
Tuf-Stuf	85–89	8–14	2–4, (Mn)
Resistac	88	10	2
Alcumite	89.75	9	1.25
Cramp Alloy 78	80	9	2
Atlas 89	80	10	1
Aluminum Bronze	90–95	5–10	(Fe, Sn, Mn)

COPPER BERYLLIUM (Beryllium 2.25)

NICKEL ALLOYS

NICKEL CHROMIUM	Ni	Cr
Q Alloy A +	66–68	19–21
Tophet A	80	20
Nichrome V	80	20
Nichrome III	85	15
Jewell-Alloy	Ni	Cr

NI CR SPECIAL	Ni	Cr	Cu	Mo	W	Si	Fe	Mn	C
Illium No. 85	53	21	6	3.5			13		
R-50	54	24	5	3.6	1.8	0.8	10	0.30	
Illium G	55	24	8	4	2		2		
Hastelloy C	58	14		17	5		6		
G-60	63	24	5	4	2	0.8	1	0.2	0.06
Pioneer Metal	Ni	Cr	Mo						

NICKEL CHROME IRON	Ni	Cr	Fe
Nichrome S	25	17	55 Si, 3
Thermalloy B	40	20	Fe C, 0.4–0.6, Mn, 1.5
Nichrome	60	15	25
Premier	60–62	14–16	25 C, 0.10
Calite N	64–68	17–20	Bal.
Inconel	80	14	6

SPECIAL	Ni	Cu	Mo	Fe	Si	Mn	Al	Co	Ti
Hastelloy A	58		20	20		2			
Monel	65–70	26–30		< 3	< 0.25	<1.5			
Konal	73.5			6				18	2.5
Hastelloy D	85	3			10		1.5		
Silicon Nickel	Ni				Si				

Readers' Forum on CHEMICAL PACKAGING

Question: As a shipper of chemicals have you any suggestions for the simplification or clarification of the I.C.C. Regulations for the Transportation of Explosives and Other Dangerous Articles?

Product Classification Would Simplify Regulations

THE VARIOUS supplements which have succeeded the original issue of the I.C.C. regulations for the transportation of explosives or other dangerous articles have made it difficult for the average shipper to keep his index up to date. The attention of the Service Department of the Interstate Commerce Commission has been called to this, and they are giving it serious consideration. Without question, a new issue embodying all supplements is greatly needed. The Technical Committees of the Manufacturing Chemists' Association have also been studying the problem, and expect to submit recommendations tending toward the simplification of the various classifications by product, which should materially clarify the issue, together with an indexing system which should be of material aid to shippers.

M. F. CRASS
Chairman, Poisonous Articles and Miscellaneous Package Committee, Manufacturing Chemists' Assn.,
Grasselli Chemical Co.
Cleveland, Ohio

How Carbide Handles A Packaging Problem

PACKAGES for most of the chemicals we produce are already prescribed by the container specifications of the Bureau of Explosives, but it may be of some interest to outline our general procedure in handling a packaging problem. It is substantially as follows:

1. Determine the chemical and physical properties of the new product, including flashpoint and corrosiveness.
2. Determine the type of container, such as glass, steel, aluminum, etc., which should be used for the new product.
3. Refer to Bureau of Explosives Pamphlet No. 9 for the regulations governing the container specifications for this type of chemical and the regulations regarding tags and shipping instructions.

It is our belief that the painting and lithographing, if any, on the shipping container should be neatly done so that the package will have an attractive appearance to the customer. The location and appearance of all placards or labels glued to the shipping container should be uniform. Any stenciling on the head of the drum should be distinct and carefully done so as to avoid smearing the ink at the edges of the letters.

When shipments are prepared for export, or in certain other cases where the package will be en route for considerable periods, it is desirable to spray the stenciling of labels on the head of the drum with some transparent lacquer or shellac to preserve the markings and permit the customer to wash off the head without damage to the stenciling. In cases of new types of containers, it is desirable to make trial shipments over various routes to determine how durable the particular container will be when handled in an ordinary manner by common carriers. Such a procedure should be made before a final decision is reached to adopt or reject the container in question.

It may be advisable to have plant representatives attend all conferences and take an active part in discussions regarding the appearance and durability of various types of containers. These men can work in conjunction with representatives of the advertising and sales departments in developing containers that are not only entirely practicable from the technical standpoint of performance, but will also incorporate the best ideas pertaining to artistic design and the appropriate printed information which will give the container the maximum of advertising value.

C. S. HEATH
Carbide & Carbon Chemicals Corp.,
South Charleston, W. Va.

New One-Piece All-Rubber Drums

THE INHERENT PROPERTIES of rubber to resist the corrosive action of a wide variety of chemicals have recently been utilized in developing a unique container for shipping and handling such corrosive liquids as muriatic, hydrofluoric, hydrofluosilicic and dilute sulphuric acids. The General rubber drum developed by the General Tire & Rubber Co. of Akron, Ohio and distributed by Maurice A. Knight, Inc. of that city, utilizes the structural strength of rubber to produce a package composed entirely of rubber compound and possessing no added metal or other reinforcement that might be subject to corrosion from the inside or the outside of the container. The result is an amazingly strong drum, which its manufacturers claim is practically indestructible. The drums are tested to stand 40 lb. internal pressure and a 6 ft. drop on solid concrete when filled with water. These drums take a lower freight rate and since they are less than half as heavy as the boxed glass carboys of corresponding capacity, there is additional savings in transportation either when filled or when returned empty.

The Manufacturing Chemists' Association passed favorably on the 5 and 13 gal. capacity General rubber drums for shipment of hydrochloric, hydrofluosilicic, muriatic and 47 per cent sulphuric acid. On May 1 they were approved by the Bureau of Explosives under specification I.C.C. 43-A. They are available either with a regular soft rubber lining or with an ebonite lining for use with materials that might be contaminated in taste or color by contact with soft rubber.

Good Books Are "Blue Chips"

To the Editor of Chem. & Met.:

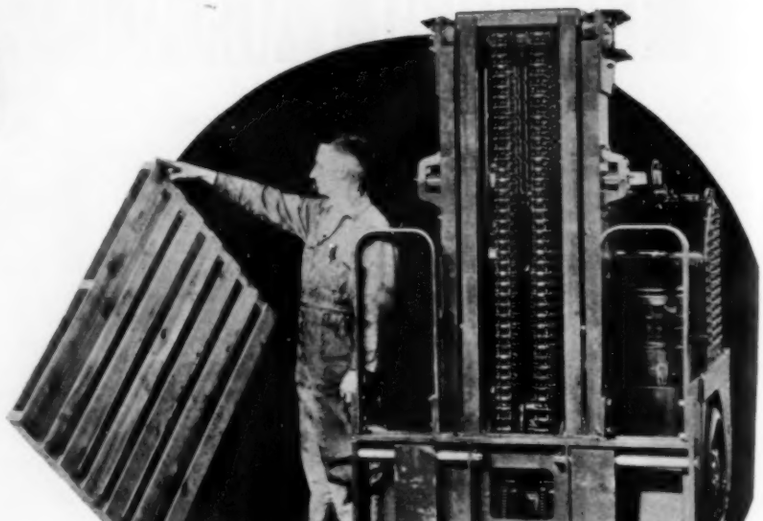
Sir—Do you think you would dare suggest in a magazine so immaculate as yours that one who only puts white chips into a poker pot seldom takes anything out? I have in mind a very large corporation that had in it at one time one of the conspicuous chemical brains of the country and this young man once proposed to the executives of the company that they spend about $300 on starting a library for their laboratory. The chief executive referred it to the watch dog who looked after the treasury and that giant went into the matter and decided, after looking at the list that the young man supplied, that $32 was the maximum they could afford to expend on the library. It may or may not have been a mere coincidence but in addition to the new books that the young chemist proposed to buy, there were $32 worth of second-hand books and also $32 worth of shelving. I am not clairvoyant and would therefore not seek to pick out which one the watch dog chose as the proper expenditure.

In any event, the chemist stayed there some four or five months and left for other fields. Today he is one of the outstanding men in the profession and I cannot think for the life of me what has become of the company that he used to be with.

JAS. O. IMXNO
Montclair, N. J.

Handling Materials Economically With New Pallet Method

No matter what form of package your product requires, this new pallet method of materials handling offers increased simplicity and flexibility. Pallets retain the advantages of skids, yet are lighter, cheaper, more compact, and permit tiering, thus saving much space in storage. They are as suitable for shipping platforms as for handling and storage



This simple pallet costs only about 80c. in quantities of one hundred; it is readily constructed with strength sufficient for the service required

Views supplied by Elwell-Parker Electric Co.

Above: Bags, boxes, barrels or bales—all are easily handled and stored on pallets

Upper Left: The height to which tiering can be carried is limited only by the ability of the truck, the strength of the package and the ceiling clearance

Left: Four heavy barrels at a clip offers no handling difficulties for the pallet method; and the barrels may be tiered as easily as boxes

Chemical Engineer's BOOKSHELF

Interpreting Research

RESEARCH—THE PATHFINDER OF SCIENCE AND INDUSTRY. By *T. A. Boyd.* Published by D. Appleton-Century Co., New York, 1935. 319 pages. Price, $2.50.

Reviewed by *S. D. Kirkpatrick*

NOT THE LEAST valuable of the products that have come from General Motors research is an abundant measure of true inspiration. For much of it, science and industry are indebted to GMR's "Boss" Kettering and his healthy dissatisfaction with status quo, to Frank Clements, its level-headed technical director, and to Tom Midgley, its brilliant and challenging showman. But behind the scenes, away from the limelight of sensational publicity, is an army of quiet, conscientious, hardworking chemists and engineers. One of these is "Tab" Boyd, Ohio State chemical engineer, who stands out from the others because of unusual ability to express his thoughts in clear, understandable English with a vividness that holds your interest like a tale of adventure. This engaging style made the author's previous book "Gasoline, What Everyone Should Know About It," one of the present-day classics among the laymen.

"Research" is an even better book because it gives Mr. Boyd a much wider field for the play of his very real talent as a guide and interpreter. It sparkles with the quoted gems of men like Kettering, Whitney and Little. It reflects, with discerning intensity, the brilliant observations of writers like deKruis and Slosson. But most engaging of all is the author's own wholesome philosophy of the purpose, program and procedures of industrial research. He has produced an intensely interesting and worthwhile book that will likely prove of value to those who really want to know what research is all about, what it offers in the way of a career for the youngster, what it offers to industry in the way of dividends.

THE CHART OF PLENTY. By *Harold Loeb and Associates.* The Viking Press, New York. 180 pages. Price, $2.50.

BASED on the findings of the National Survey of Potential Product Capacity the authors have arrived at many conclusions which are in distinct opposition to various popular ideas regarding the economic problems of the country. These have been embodied in a large graph, the "Chart of Plenty," and most of the text is devoted to the explanation of this chart. The results of the survey indicate an average yearly potential output of goods and services to the consumer valued at $4,400 per family, if all existing plant and man power of the country were fully employed. Actual production in 1934 was probably not much above $1,800, with the majority of families receiving far less. The difference between the two figures, according to the authors, is the price paid for maintaining an economic system which concentrates on the production of dollars rather than of goods.

Berl's Second Volume

CHEMISCHE INGENIEUR—TECHNIK, VOL. II. Edited by *Ernst Berl.* Published by Verlag von Julius Springer, Berlin. 795 pages. Introductory price for series of three volumes, 248 Rm. Volumes not sold separately. Later subscription price will be 310 Rm.

Reviewed by *S. D. Kirkpatrick*

THIRTEEN SECTIONS are contained in the second volume of Prof. Ernst Berl's handbook, the first volume of which was reviewed in the March issue of *Chem. & Met.* As in the first volume the leaders in their respective fields of German chemical industry are found among the collaborators; and in the treatment of the various subjects the theoretical and the practical side have again, as far as possible, been given equal rank. Roughly speaking, this volume divides itself between two main subjects, viz., heat and power generation and movements of materials. Under the first classification we find the following chapters: Power Technique, by Dr. W. Speidel, Halle-a.-S. and Dipl. Ing. K. Kranz, Mannheim; Combustion and Boiler Practice, by Dipl. Ing. Eckart Richter, Wuppertal-Elberfeld; Purification, Softening, and Degassing of Industrial Water, and Sewage Treatment, by Prof. Berl and Dr. R. Bemmann, Darmstadt; Heat Transfer, by Dr. E. Hegelmann, Ludwigshafen a.Rh.; Drying, by A. Romer, Hersfeld, and Dr. L. C. Simon, Ludwigshafen a.Rh.; Industrial and Electric Furnaces, by Dr. K. Thormann, Breslau; and Refrigeration by Dr. M. Gompertz, Berlin.

The second general division of this volume is treated in the following chapters: Plant Location and Construction, by Dr. K. Thormann, Breslau; Compression and Flow of Air and Gases, by Dipl. Ing. H. Haehndel, Berlin-Tegel; Flow of Liquids, particularly Acids and Alkalis, by Dipl. Ing. E. Wisotzky, Berlin; Movement of Solid Materials, and Storage, by Dr. K. Thormann, Breslau. Like the first, the second volume abounds with excellent illustrations, graphs, and tables. The third and concluding volume is scheduled to appear in the near future.

Chem. & Met.

COURSES IN CHEMICAL AND METALLURGICAL ENGINEERING. University of Michigan Official Publication, Vol. XXXVI No. 56, April 13, 1935. 56 pages.

MICHIGAN'S chemical engineering bulletins are unique among departmental catalogs because of their philosophical approach to the educational problems of the profession. The 1935 edition is no exception in this regard but it also introduces several features worthy of careful attention. Note first the change in the name of the department to a rather familiar and significant compounding of "Chemical and Metallurgical Engineering." For the first time there are listed special programs in metallurgical engineering leading to a separate degree, B.S.E. (Met. E.) which is indicative of the increasing importance of this subject at Michigan and the reason a separate course has now been authorized. Lists of the 43 doctorates conferred since 1929 and of the staff publications from 1930 to 1934 are impressive additions to the present booklet. And, last but not of least importance, is a very successful attempt to get away from the drab covers of the past, substituting in their place, some striking examples of modern photography as applied to pertinent industrial and university scenes.

STRUCTURE AND PROPERTIES OF MATTER. By *Herman T. Briscoe.* McGraw-Hill Book Co., New York. 420 pages. Price $3.75.

WITH the passing of the time-honored idea of a rigid, indivisible atom the chemist of today is constantly forced to make revisions of his conception of matter. So rapid and revolutionary have been the changes in this field during the last two decades that few, except those specializing in this phase of physical chemistry, have been able to keep up with the progress. In this volume, one of the International Chemical Series, the author has attempted to describe this development to the student and chemist of industry.

The first chapters of the book are mainly of historical interest, discussing

the opinion of the Greek philosophers, the story of the alchemists with the crude beliefs of the "Dark Age," the budding scientific thought of the seventeenth and the eighteenth century, and the real achievements of the nineteenth century. The remainder of the volume deals with present day developments, studies of radioactivity, the electron and the proton, the atomic nucleus, crystal structure, atomic structure, valence, and the new quantum mechanics.

FORTSCHRITTE IN DER ANORGANISCH-CHEMISCHEN INDUSTRIE. Vol. IV, Part II, 1928-32. By *Adolf Bräuer* and *J. D'Ans*. Julius Springer, Berlin. 2,473 pages. Price, 198 Rm.

A REVIEW of the progress in inorganic chemistry, based on German patents for the period 1928-32. The present volume deals with nitrogen, phosphorus, fertilizers, arsenic, antimony, vanadium, columbium, tantalum, carbon, silicon, boron and tin. Two more volumes have been scheduled to complete the five-year period, another volume will cover 1933 and 1934, whereupon each year will be treated separately, with comprehensive summaries of the individual groups every five years.

ORGANIC SYNTHESES. Vol. XV. An annual publication of satisfactory methods for the preparation of organic chemicals. John Wiley & Sons, New York. 104 pages. Price, $1.75.

THIRTY new syntheses are included in this volume. Later references to preparations in the preceding volumes and additions and corrections to these volumes are compiled in an appendix.

CHEMICAL GUIDE-BOOK. Eleventh (1935) Edition. Published by Chemical Markets, New York. 803 pages.

A CATALOG of leading chemical firms in the United States, and a listing of the products manufactured. In this edition 108 pages with 153 new chemicals and 160 new synonyms have been added.

CHEMISTRY AND TECHNOLOGY OF WINES AND LIQUORS. By *Karl M. Herstein* and *Thomas C. Gregory*. D. Van Nostrand Co., New York. 360 pages. Price, $5.50.

UP-TO-DATE data on the manufacture and testing of distilled liquors and wines are contained in this volume. It discusses every step in the production, from the selection of raw materials to the final aging and blending, giving the oldest methods still in use as well as the most modern installations, in this country and abroad.

PRAKTISCHE METALLKUNDE, Vol. III. By *George Sachs*. Verlag von Julius Springer, Berlin. 203 pages. Price, 17 Rm.

HEAT-TREATMENT of ferrous and non-ferrous alloys is the subject taken up in the third volume of Dr. Sachs' excellent handbook. The first chapters are devoted to the study of phase diagrams and structural changes, with discussion of the latest x-ray methods for the study of crystal structures. In the following chapters the author takes up the heat-treatment of the alloys of aluminum and other light metals, of copper, nickel and cobalt, the precious metals, iron and steel, and alloys of low melting points. Magnetic properties of alloys are discussed in the last chapter.

METALLURGY. By *E. L. Rhead*. New Revised and Enlarged Edition. Longmans, Green & Co., New York. 382 pages. Price $4.

AMONG the important changes in the revised edition are the chapters on pyrometry, metallography, and foundry work, which contain sufficient fundamental matter to serve as a basis for more advanced study. Additions have also been made to the chapters dealing with physical testing and fuels, especially modern byproduct coke plants.

GOVERNMENT PUBLICATIONS

Documents are available at prices indicated from Superintendent of Documents, Government Printing Office, Washington, D. C. Send cash or money order; stamps and personal checks not accepted. When no price is indicated pamphlet is free and should be ordered from bureau responsible for its issue.

Silicosis, by R. R. Sayers. Public Health Service Reprint No. 1625 (Revised 1935); 5 cents.

Regulations for the Transportation of Explosives and Other Dangerous Articles on Public Highways by Motor Truck or Other Vehicle, Including Specifications for Shipping Containers. Part VI, effective March 1, 1935, Interstate Commerce Commission; 5 cents.

Quicksilver Deposits Near Little Missouri River and Near Antione Creek, Southwestern Arkansas, by John C. Reed and J. M. Hansel. Department of the Interior Release April 30, 1935; mimeographed.

List of American Doctoral Dissertations Printed in 1933. Library of Congress, unnumbered document; 60 cents.

Annual Census of Clay Products, Nonclay Refractories, and Sand-Lime Brick, 1934. Bureau of the Census Release of May 22, 1935; mimeographed.

Quality of Cotton Linters Produced in the United States, Season 1933-34, by Victor R. Fuchs. Bureau of Agricultural Economics, Preliminary Report; mimeographed.

Mechanical Cleaning of Bituminous Coal 1929 to 1934, by L. N. Plein. Bureau of Mines Weekly Coal Report No. 930, May 11, 1935; mimeographed.

Beneficiating Cement Raw Materials by Agglomeration and Tabling, by F. P. Diener and others. Bureau of Mines Report of Investigations 3247; mimeographed.

Matches. Tariff Commission Report No. 94, Second Series; 5 cents. Résumé of information on production, sales, and numerous trade aspects.

Sodium Sulphate, by Paul M. Tyler. Bureau of Mines Information Circular 6833; mimeographed. Résumé of information on production, sales, utilization, and numerous trade aspects.

Minor Mineral Fertilizer Materials, by Bertrand L. Johnson. Bureau of Mines Information Circular 6830; mimeographed. A résumé of information on production, sales, utilization, and other trade aspects.

Clay, by Paul M. Tyler. Bureau of Mines Information Circular 6155, Revised March, 1935; mimeographed. A résumé of general technical statistical and trade information.

Beneficiating Cement Raw Materials by Agglomeration and Tabling. by F. P. Diener and others. Bureau of Mines Report of Investigations 3247; mimeographed.

Review of Literature on Effects of Breathing Dusts With Special Reference to Silicosis, by D. Harrington and Sara J. Davenport. Bureau of Mines Information Circular 6835; mimeographed. Contains chapters on definition and classification of dusts; sources of exposure to dusts; physiological effects of breathing dusts.

Textile Industries. Report of the Federal Trade Commission in five parts as follows: Part I, Investment and Profit; Part II, the Cotton Textile Industry; Part III, The Woolen and Worsted Textile Industry; Part IV, The Silk and Rayon Textile Industry; Part V, Thread, Cordage, and Twine Industries; 5 cents each.

Crude Phosphates and Superphosphate. Tariff Commission Report; mimeographed.

Production of Paper and Paperboard, Paper-Making Machines in Use. Census of Forest Products, 1934, Bureau of the Census Release May 31, 1935.

Special Multiple-Shot Blasting Units, by A. B. Hooker and E. J. Coggeshall. Bureau of Mines Report of Investigations 3269; mimeographed.

Coke-Oven Accidents in the United States During the Calendar Year 1933; by W. W. Adams and V. E. Erwin. Bureau of Mines Report of Investigations 3273; mimeographed.

Mica, by F. W. Horton. Bureau of Mines Information Circular 6822; mimeographed. Discusses mining, processing, uses, and trade conditions.

The Fertilizer Industries, by Paul M. Tyler. Bureau of Mines Information Circular 6834; mimeographed. General information to supplement individual fertilizer materials reports.

Mineral Production Statistics for 1934—preliminary mimeographed statements from Bureau of Mines on: Liquefied petroleum gases; tungsten; mercury; manganese; carbon black; pyrites; flourspar; rolled zinc; cadmium; magnesium; salt, bromine, calcium chloride, and iodine.

Production Statistics From 1933 Census of Manufactures—printed pamphlets on: Power laundries; cleaning and dyeing establishments; rug-cleaning establishments: The drug industries; soap; baking powder, yeast, and other leavening compounds; printing ink; cottonseed oil, cake and meal: Asbestos Products, Steam and other packing, pipe and boiler covering, and gaskets; cement; clay products and sand-lime brick; concrete products; glass; marble, granite, slate, and other stone products: The tobacco industries; tobacco pipes; alcoholic beverages; nonalcoholic beverages; malt: Manufactured gas; coke-oven products; petroleum refining: Canning and preserving; food preparations not elsewhere classified; vinegar and cider. 5 cents for each pamphlet.

Specifications. New or revised specifications of the Federal Specifications Board or Navy Department on: Lubricants and liquid fuels, general specifications, Federal spec. VV-L-791a, 15 cents; White lead, basic-carbonate, dry, paste-in-oil, and semi-paste containing volatile thinner, Federal spec. TT-W-251a, 5 cents; Bronze, manganese, bars, plates, rods, and shapes, Navy spec. 46B15c; Carbons, searchlight (high-intensity), Navy spec. 17C7b; Graphite, lubricating, flake, Navy spec. 14G3e; Soda, caustic, Navy spec. 51S25a; Benzol, Navy spec. 51B3c; carbon dioxide (CO_2), compressed, Navy spec. 51C16b. Navy specifications are available from the Bureau of Supplies and Accounts, Navy Department, Washington, D. C.

Index of Specifications Used by the Navy Department for Naval Stores and Material, corrected to and including Jan. 2, 1935. Bureau of Supplies and Accounts, Navy Department.

Biennial Census of Manufactures, 1931. Bureau of the Census. 1281 pages, $1.75, buckram.

Your Plant NOTEBOOK

Concentration Conversion Chart For Oleum

By D. S. DAVIS
Dale S. Davis' Associates
Watertown, Mass.

CONCENTRATION of fuming sulphuric acid is stated in the following three ways: (1) as the percentage of free or dissolved sulphur trioxide; (2) as the percentage of total sulphur trioxide; and (3) as the percentage of 100 per cent H_2SO_4, the latter being understood as the amount of 100 per cent H_2SO_4 which would be present if enough water were added to combine with the free sulphur trioxide. In addition it is often desirable to know the amounts of combined sulphur trioxide, combined water, and the H_2SO_4 equivalent to the combined water.

The best tables of fuming sulphuric acid data list the percentages of free SO_3 in steps of 1 per cent and the percentages of total SO_3 and of 100 per cent H_2SO_4 in steps of 0.1 per cent and permit values of the remaining five concentrations to be read with ease in each of the three cases. However, where the argument is the concentration of combined SO_3, of combined water, or of its sulphuric acid equivalent, the situation is not as favorable and resort must be made to annoying interpolations.

Chemical engineers working in this field will find that the accompanying concentration conversion chart facilitates interpolation and yields values of the six corresponding concentrations at a glance. For most convenient use an enlarged photostat of the chart should be mounted in a frame with a raised straight-edge parallel to the scales. The raised edge can then serve as a guide along which to slide a triangle. Horizontal lines will cut the six scales in the correct corresponding values. Thus, one set of concordant data, reading from left to right, is

110 per cent of 100% H_2SO_4
89.8 per cent total SO_3
44.4 per cent free SO_3
45.4 per cent combined SO_3
10.2 per cent combined water and
55.6 per cent H_2SO_4 equivalent to the combined water.

The relationships involved are:

Per cent total $SO_3 = 0.8163 \times$ per cent 100% H_2SO_4.

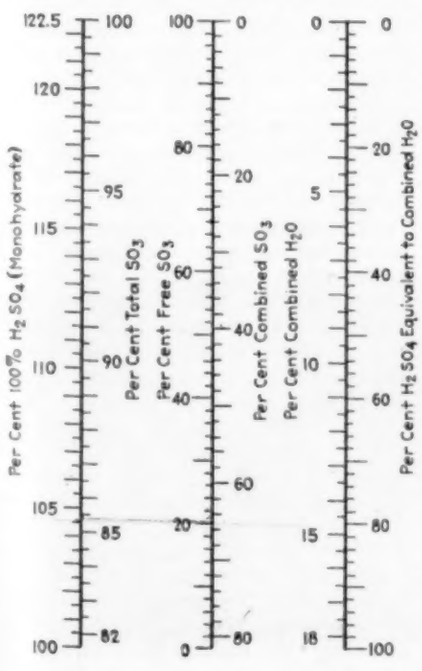
Per cent free $SO_3 = 5.444 \times$ per cent total $SO_3 - 444.4$.

Per cent combined SO_3 = per cent total SO_3 — per cent free SO_3.

Per cent combined water = 100 — per cent total SO_3.

Per cent H_2SO_4 equivalent to the combined water = 100 — per cent free SO_3.

Conversion chart for oleum concentration


Per Cent 100% H_2SO_4 (Monohydrate)
Per Cent Total SO_3
Per Cent Free SO_3
Per Cent Combined SO_3
Per Cent Combined H_2O
Per Cent H_2SO_4 Equivalent to Combined H_2O

Simple Fusible-Link Safety Device

By E. F. von Wettberg, Jr.
Chemical Division
The R. & H. Chemicals Department
E. I. duPont de Nemours & Co.
Niagara Falls, N. Y.

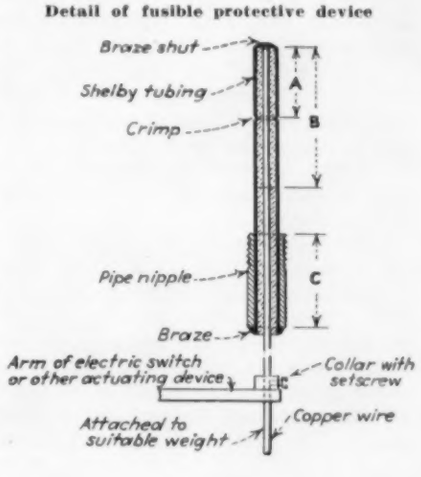
SUPPLYING a simple, reliable and yet inexpensive device to guard against overheating is a common problem in both the plant and the laboratory. An adaptation of the familiar "fusible link" finds a wide application in work where such a device is desired. It is shown at the right.

Briefly, the apparatus consists of a length of ¼-in. 20 ga. Shelby tubing, closed at one end, with a threaded ⅛-in. standard pipe nipple for screwing into the equipment to be protected, brazed to the other. A length of 16-ga. copper wire is held in place inside the tube by a plug of fusible metal chosen for proper softening temperature. A weight attached to the wire pulls it out at the dangerous temperature, breaking an electrical contact in so doing.

The fusible element is particularly positive in action since its small heat capacity and metallic construction combine to reduce lag in reaching the temperature of the medium, while the heavy weight assures definite clearing of the wire. In most cases metals and alloys lose strength rapidly near their melting points so that the wire will pull out at a temperature somewhat lower than would be predicted from phase data alone. For this reason, operating temperatures must be determined experimentally for each plug composition. Characteristics of different elements using the same plug composition are virtually identical.

Materials found to be especially satisfactory for plugs are tin, lead, tin-lead alloys, Wood's metal, Darcet's metal and similar alloys. All dimensions can obviously be varied to suit the individual application. Convenient dimensions are: A=¾ in., B=1½ in., and C=1 in. Size of the operating weight can also be varied; 5 lb. has been found to be satisfactory.

Detail of fusible protective device



News of EQUIPMENT

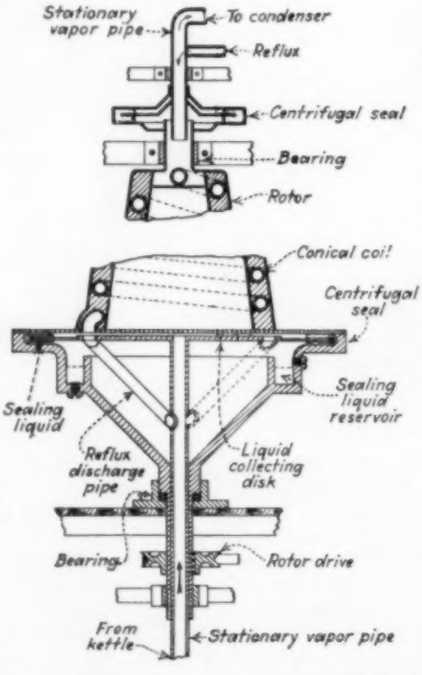
Insulating Cement

A new insulating cement known as Sonittep, useful both for high- and low-temperature insulation, which can be applied both to hot and cold surfaces, has recently been developed by George F. Pettinos, Inc., 1206 Locust St., Philadelphia, Pa. The cement requires no reinforcement and withstands temperatures to 2,000 deg. F. It is said to be reclaimable when used at temperatures not exceeding 1,400 deg. F. The cement is shipped dry and requires only the mixture with water for application. A quantity of 100 lb. of cement will cover 50 sq. ft., 1 in. thick, and can be applied by unskilled labor. tI is said to have about three times the covering capacity of asbestos cement and four times the insulating value, showing a heat transmission considerably below that of 85 per cent magnesia.

Super-Contacting Device

A new form of centrifugal apparatus for producing extremely intimate contact between fluids of different densities, to which has been given the name of centrifugal, countercurrent Super-Contactor, has recently been announced by Walter J. Podbielniak, of the Podbielniak Industrial & Research Laboratories, 222 East Superior St., Chicago, Ill. The device was described and its principles disclosed in a paper presented before the recent New York convention of the American Chemical Society. Remarkable claims have been made for the efficiency of the Super-Contactor in such diversified applications as fractional distillation, gas absorption, countercurrent contacting of immiscible liquids, as in solvent extraction, and in gas washing and cleaning.

Whereas the usual types of equipment for contacting fluids of different densities depend solely upon gravity for their separating effect, the new apparatus employs centrifugal force which can be developed to any desired degree by proper choice of the speed of rotation of the rotor, and through its suitable design. The duration of contact between the fluids can be fixed at any desired time through choosing a suitable pitch and length of passageway in the rotor and a suitable speed of rotation. If sufficient length cannot be obtained in a single rotor, it claimed that several rotors in series may be used. Thus, through the controllable combination of these two factors—separating effect and duration of contact between the fluids—plus an extremely high degree of turbulence which is said to be inherent in this type of apparatus, the results that are attained are reported to be superior to those to be had with much bulkier equipment of earlier types.



Cross-sectional view of conical support type of centrifugal fractionating device

One form of the Super-Contactor is illustrated in the accompanying drawing. As shown it is adapted to fractional distillation. The principal element of the apparatus is a conical rotor containing a spiral passageway, shown as circular in cross-section, but preferably square. In order that vapor may be introduced into the lower end of the coil, a stationary vapor pipe rising from the still kettle is brought into gas-tight contact with the rotor by means of a centrifugal liquid seal. A similar seal is employed at the upper end of the rotor to connect with the stationary discharge pipe. Reflux liquid which flows from the lower end of the coil is prevented by the seal from dropping into the rotating conical bottom of the apparatus, backing up on the stationary liquid collecting disk and flowing downwardly through the discharge pipes to the kettle.

The action of the equipment is as follows: When the rotor is started, the sealing liquid flows from its storage reservoirs within the rotor seals, and seals the edges of the stationary disks. Reflux liquid introduced at the top of the apparatus flows down through the coil as a thin layer which, through centrifugal action, follows the outer periphery of the coil, where it is accelerated both by gravity and by the tangential component of the centrifugal force (due to the increasing diameter of the spiral). Vapor from the still kettle, entering at the bottom of the rotor, flows upwardly through the coil and follows its inner periphery. The driving force impelling the vapor is the pressure difference between the still and the condenser, and this is opposed by the tangential component of centrifugal force against which it is working. With the use of liquid velocities of about 6 ft. per second, and of vapor velocities in the neighborhood of 40 to 80 ft. per second, the counterflow contact between the two phases at their interface is said to result in so high a degree of turbulence that each foot of spiral passage is equivalent to about 1½ gravitational bubble plates. At the same time, the centrifugal force tending to separate the two phases is said to prevent foaming or entrainment.

Although this description applies to distillation, it is not difficult to extend these operating principles to other operations for which the equipment is adapted. In distillation, there is a continuous interchange of heat between the counterflowing streams of hot vapor and colder reflux liquid. As this occurs, the ascending vapor becomes progressively stronger in the lower boiling component, and the descending liquid, progressively stronger in the higher boiling component. Since in a single rotor it is possible to employ from 45 to 100 ft. of spiral passage, it is evident that the equivalent of more than 100 plates can be included within a small volume. For example, in an apparatus of 500 gal. per hour capacity, equivalent to 100 plates, the total volume occupied is 4 by 4 by 6 ft. By multistaging rotors, the equivalent of 1,000 plates can be obtained, thus making possible separa-

tions that are totally impractical for gravity distilling apparatus.

Because of its small size it is said to be practical to construct the apparatus from special metals or alloys, at cost comparing favorably with the corresponding gravity apparatus. For most purposes, the power consumption required to drive the rotor is small, not more than 1 hp., even in the larger sizes. As indicated above, very large capacity for small apparatus is indicated. Operating cost is said to be lower than that of comparable gravity equipment, while other advantages include superior flexibility, portability and dependability, combined with extremely small inventory of material in process, and ready maintenance.

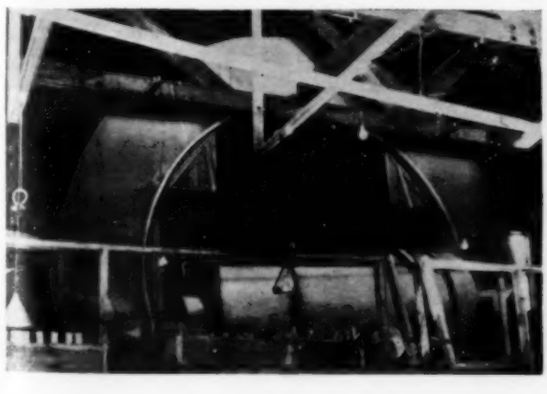
Improved Grinding Mill

The Hardinge Co., Yorke, Pa., announces that it has now completed development work and redesign on the Hardinge-Hadsel mill, that six installations operating on eight different types of ore have been performing satisfactorily and that operating results may now be published. This mill, originally described in *Chem. & Met.*, p. 257, May, 1933, was found in its original form to be satisfactory in principle but to give difficulty in practice. While it crushed and ground both hard and soft ores at very low power consumption and operating cost, its maintenance was high and certain sizes of crushed product tended to build up inside the mill. In the new design, only the main feature of the old, that of breaking ore by dropping it upon breaker plates, has been retained. The mill now consists of a revolving drum supported on a cradle of rollers. Within the drum are buckets which lift the material and drop it upon stationary breaker plates supported from the outside. The finest material, discharging first, falls on to a discharge grizzly where material passing through leaves the mill, going to a classifier. Heavier material slides on to a breaker plate and thence continues the grinding cycle. A sketch showing the major features of construction of the new mill appeared on page 208 of our issue of April, 1935.

An important feature of the new mill is that it requires no preliminary crusher. In one machine it converts from mine-run size to any degree of fineness required. Extensive operating tests have shown that the consumption of metal in grinding is not more than ½ lb. per ton in a large mill nor more than ¾ lb. per ton in a small mill.

Typical of the operating results obtained with this mill is the following from a Colorado mine grinding a gold ore, composed of quartz stringers in granite. The mill, which is close-circuited with a Hardinge countercurrent classifier, is of 20 ft. diameter, operating on run-of-mine ore and producing a product of 5 per cent plus 65 mesh at the rate of 55 tons per 24 hours. The power consumption is 29 hp., the speed of mill 3.0 r.p.m. and the percentage of solids in classifier overflow is 35 to 40. The saving in grinding cost with this mill over other grinding equipment varies with the size of installation, but generally amounts to 50-65 per cent, including labor, power, repairs and maintenance, on products averaging 2 per cent plus 65 mesh.

Hardinge-Hadsel mill installed in a New Mexico mine plant



Magnetic Separator

A new magnetic separator, the "FerroFilter," which has been designed by S. G. Frantz for removing extremely fine particles of magnetic materials from slips, clays, glazes, enamels and slurries, has recently been put on the market by the Separations Engineering Corp., 110 East 42d St., New York City. The new separator consists of a separating chamber filled with highly magnetized screens or grids, fed by means of a hopper. Since highly magnetized edges are most effective in separation, this separator has about 700 ft. of collecting edge on the screens, highly magnetized by a coil and magnetic circuit. In passing through the screens, no particle can be farther than ⅛ in. from a collecting edge. With 17 staggered screens to be traversed, each particle has many opportunities to be captured. The separator is made in three sizes for handling 100, 900 and 2,350 gal. per hour. Power consumption for the medium-sized machine is about 100 watts.

The separating intensity of the FerroFilter is so high that materials previously purified by magnetic or other processes show further separation in this machine. Separation is said to be highly effective on extremely fine particles, resulting in a marked lightening of the shade of the finished body. In operation, the separator may be wheeled over a receiving tub and the slip poured through. A float-operated regulator valve keeps the machine flooded regardless of rate of feed. An automatic shut-off valve closes instantly should the power go off. Cleaning is readily accomplished at such intervals as may be required by the material being treated.

Frantz FerroFilter in 900 gal.-per-hour size

Equipment Briefs

"Therm-O-Tile" is the name of a new underground steam conduit system recently developed by H. W. Porter & Co., Newark, N. J. In installation, a concrete base 4 in. thick is first poured directly into the trench bottom. On this the conduit and piping rest independently of each other. No broken stone fill or underdrain is employed. All tile sections are of double thickness with integral air spaces and are designed so that the cement used for sealing is locked into grooves and cells in the tile, producing joints that are said to remain tight indefinitely.

Bailey Meter Co., 1050 Ivanhoe Road, Cleveland, Ohio, has announced a new fuel flow-air flow meter, intended as a guide for operators of furnaces and kilns, so that they may obtain maximum combustion efficiency. The meter, a recorder, employs two pens, one recording the rate of fuel flow and the other the flow of air. At the time the meter is installed, a complete combustion test is made to determine the most suitable ratio between these factors. Once this is determined, the meter is adjusted so that the two records coincide at the optimum ratio. The operator, therefore, has only to keep the two pens together to secure the highest possible efficiency of operation.

Reconditioning of returnable containers used for the bulk shipment of chemicals is said to be greatly simplified by a barrel renovator developed by the

Harnischfeger Corp., Milwaukee, Wis. The machine cleans barrels inside and out, employing a cleaning solution which may be either hot or cold. This is force-sprayed against the walls by means of a revolving spray nozzle. Average cleaning time is stated to be 1½-2 min. The machine handles barrels of various sizes in either horizontal or vertical positions and is available in one-, two-, four- and multiple-spindle models.

For heavy screening of both wet and dry materials, the Smith Engineering Works, Milwaukee, Wis., has recently developed a new vibrating screen unit known as the Telsmith Pulsator. Actuation of the screen is obtained through the use of a rotating shaft carried on self-aligning outboard bearings, mounted on a supporting frame.

The shaft, in turn, supports two eccentric bearing housings, to which the screen decks are attached. Particular care has been taken in the bearing seals to avoid entrance of dirt and grit. The throw of the screen is balanced by means of heavy flywheels counterweighted to prevent the transmission of vibration to the supporting structure.

A new anode, recently announced by Hanson-Van Winkle-Munning Co., Matawan, N. J., has been given the name ZAM (zinc, aluminum, mercury) and is designed to avoid sludging and anode polarization in zinc plating. It is stated that hydrogen is not included in the deposit. The new anode is not attacked either by acid or cyanide solutions until the current is applied. ZAM anodes are available in the form of balls, bars or plates.

A device originally developed for breaking ice cakes, known as the Creasey material breaker and built by the Cochrane Corp., 17th and Allegheny Ave., Philadelphia, Pa., has recently been used in chemical plants for breaking down cakes of rosin, naphthalene, mineral rubber, carbolic acid, borax, shellac and similar materials. The breaking is accomplished by sharp pointed picks held by friction in pockets in the periphery of a heavy cast-iron rotating drum. The size of the broken material is determined by interchangeable combs through which the broken pieces must pass before leaving the machine. Such breakers are furnished in capacities ranging up to 50 tons per hour, capable of handling pieces of material as large as full-sized cakes of ice.

A simplified time-cycle controller, known as the "Intermitter," has been introduced by the Taylor Instrument Cos., Rochester, N. Y., for controlling single operations which are repeated. The instrument differs from the company's time-cycle controller in that only a single operation, rather than a number of different operations, may be controlled. The device has a circular cam on which the proper number of actuating lugs (up to 20) may be placed at the desired time intervals. These lugs operate an air valve which, by its adjustment, controls the duration of the repeated operation.

A new coating for plating racks, which is said to be both corrosion resistant and non-contaminating, has been announced by the B. F. Goodrich Co., Akron, Ohio. This material is known as Korolac and possesses high dielectric resistance and is translucent, tough and inert. Tests have shown Korolac to be unaffected by solutions ordinarily used in plating baths. This material is a solution of Koroseal, this company's new synthetic rubber-like material.

Greene, Tweed & Co., 109 Duane St., New York City, has developed a new pump packing, employing a tasteless, odorless and colorless lubricant which contains no graphite. The material is, therefore, said to be suitable for pumps handling edible products and other materials that must not be contaminated with graphite.

A new line of valve handwheels, molded in colored plastic material to make possible ready identification of the material handled in the valve, has been announced by Jenkins Bros., 80 White St., New York City. The wheels are available, unmarked, in five standard colors, and also with five standard surface markings molded in relief. In addition to their aid to identification, the new wheels are said to be strong and cool to the touch.

Straight-Line Dialyzer

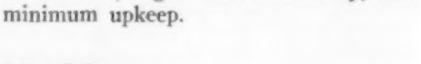
For the recovery of contaminated caustic solutions, particularly in rayon plants, the Casey straight-line dialyzer is being offered by Alexander, Casey & Alexander, 12 South Ave., Media, Pa. The dialyzer is formed by placing units end to end, each unit being composed of from three to 61 frames. These can be arranged in various numbers from ten units of three frames each, up to ten units of 61 frames each, according to the requirements of the plant. Each frame is made of cold rolled steel and frames are placed flat, one upon the other, alternating water frames and caustic frames. Each frame contains 33 tubes wrapped with wire to control the flow. The units are connected by flexible tubing and each frame has a by-pass so that any frame may be cut out and the membrane changed without stopping the apparatus.

The membrane supplied is of a special type said to give extremely close results, and is guaranteed for three months. The dialyzer of ten units of three frames each will recover 14,400 lb. of 8 per cent caustic at 90 per cent efficiency daily, while ten units of 61 frames each will recover 250,000 lb. of 8 per cent caustic at 90 per cent efficiency daily.

Among advantages claimed for the apparatus are its small floor space requirement, flexibility, ease of changing membranes, high rate of recovery, and minimum upkeep.

Lined Pump

Notable reductions in pump maintenance cost are said to be possible through the use of a pump with removable liners which has been added to the standard line of turbine pumps made by the Westco Pump Corp., Davenport, Ia. It is stated that, should replacement of liners ever be necessary, the job can be done without disturbing the installation of the pump or the piping connections and can be accomplished in a few minutes' time. The saving, it is stated, is particularly large in the case of alloy construction for it is often possible to use cast iron or bronze casings with alloy liners. The amount of comparatively high-cost alloy metal required to make the liners and impeller is said to be about 73 per cent less than the amount required for casting the complete pump casing.



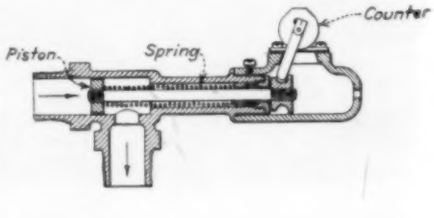
Disassembled view of pump with removable liners

Another advantage of the removable liners is that the capacity and head of the pump may be readily increased or decreased within reasonable limits. This is accomplished simply by interchanging the different sized set of liners and possibly by using another impeller.

Flow Interruption Meter

A device for counting the number of interruptions of flow of steam, liquids, air and gases, has recently been announced by Ammann-MacGregor, Inc., 2217 Olive St., St. Louis, Mo. This device, known as the Colley meter, was developed originally in a chemical plant

Cross section of flow interruption meter



where it was used to record the number of times a steam trap operated. Thus it served as a condensate meter. It is also useful in showing whether the trap is operating properly and, if fitted with an electrical attachment, gives a warning when flow stops.

The drawing shows the construction of the meter. It has a loosely fitted piston which does not respond to pressure changes, but only to interruptions of flow. When flow commences the piston moves toward the right and operates the counter. When flow is interrupted, the spring returns the piston to the position shown in the drawing.

Oil Heater

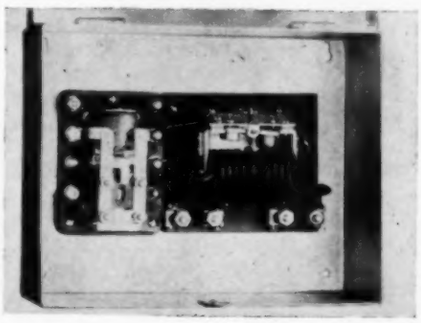
To insure high thermal efficiency in oil heating, the Lummus Co., 50 Church St., New York City, has developed a new oil heater in which the two sidewalls, the roof and sometimes the floor of the radiant section are covered with heat absorbing surfaces. Above the radiant section is a plenum chamber for collecting the flue gas and immediately above this is the convection section. The heater utilizes a large portion of the wall area for radiant heating surface and through distribution of the tubes is said to assure most effective absorption of radiant energy without overheating. The arrangement of tubes in the convection section is such as to create a high gas velocity and a long travel of gas, so that the flue-gas temperature is reduced to a minimum before leaving the heating unit.

Through the use of high furnace temperature in the radiant section and only a small amount of excess air, the amount of convection surface required is relatively small in comparison with older heaters. Nevertheless, tests have shown a flue-gas temperature of only about 200 deg. F. over the temperatures of the incoming oil. Other tests have shown, according to the manufacturers, a capacity per square foot of heating surface equal to 200 per cent of that of a conventional heater operating at the same efficiency.

Novel Relay Application

A unique application of relays made recently by Struthers Dunn, Inc., 139 North Juniper St., Philadelphia, Pa., is being used in controlling the load on a motor used to drive an agitator in a mixing tank. At the start of the operation the mass being mixed is composed half of liquid and half of solid matter. The tank is steam-heated and the liquid evaporates, increasing in viscosity and raising the motor load. The relay is connected into the motor line so that when the load increases with increase in viscosity, a solenoid valve from a feed tank is opened, adding more of the solution so as to maintain substantially constant motor load and constant viscosity.

Relay used in mixing operation



MANUFACTURERS' LATEST PUBLICATIONS

Bearings. New Departure Mfg. Co., Bristol, Conn.—144-page Tenth Edition Catalog of this company's bearings, with complete listing of types and sizes, and engineering data on the use of ball bearings.

Bearings. The Timken Roller Bearing Co., Canton, Ohio—260-page looseleaf Third Edition of this company's Engineering Journal, bound in three-ring binder with stiff covers; contains information on design of bearings, detailed dimension sections, and complete information on applications, lubrication and accessories.

Bentonite. American Colloid Sales Division, Inc., 363 West Superior St., Chicago, Ill.—Series of 17 technical bulletins on the history, properties, composition and uses of Volclay Wyoming bentonite with complete explanation of principles and description of techniques of use. Lists and describes numerous patents in various fields of use.

Boilers. Combustion Engineering Co., 200 Madison Ave., New York City—Folder P-122—4 pages describing this company's bent-tube boiler for medium-sized and small plants.

Cements. U. S. Stoneware Co., Akron, Ohio—Bulletin 801—4 pages on this company's acidproof brick and cement.

Chemicals. Standard Silicate Co., Koppers Bldg., Pittsburgh, Pa.—12-page booklet on the grades, properties and uses of this company's sodium silicates.

Compressors. Ingersoll-Rand Co., Phillipsburg, N. J. — Form 3344 — 48 pages describing a line of steam-driven compressors in sizes ranging from 50 to 1,500 hp.; Form 7502-D, 32 pages on this company's Type 30 industrial compressors and vacuum pumps, 4 to 15 hp.

Conduits. H. W. Porter & Co., 825 Frelinghuysen Ave., Newark, N. J.—Bulletin 351—8 pages describing this company's underground conduit system for steam piping, which features support, protection and insulation.

Electrical Equipment. General Electric Co., Schenectady, N. Y.—GEA-77H—26 pages on Pyranol-filled capacitors for improving power factor.

Electrical Equipment. Ideal Commutator Dresser Co., Sycamore, Ill.—Leaflet describing a new combination test light and fuse puller made by this company.

Equipment. Ajax Flexible Coupling Co., Westfield, N. Y.—4-page booklet describing the Shaler Shaker.

Equipment. Cleveland Brass Manufacturing Co., 4606 Hamilton Ave., N. E., Cleveland, Ohio—13 pages with description and engineering data on this company's Aciment chemical pumps and chemical valves.

Equipment. Ross Heater & Mfg. Co., Buffalo, N. Y.—Publications as follows: Form 1037, Sterling oil sections; 1039, Expansion joints; 1040, Metal pipe; 1041, Storage tank heaters; 1043, Steam jet refrigeration.

Furnaces. Hevi Duty Electric Co., Milwaukee, Wis.—Bulletins HD535 and 635—Respectively 4 and 2 pages describing muffle furnaces for laboratory use and pot-type electric furnaces.

Heating Units. Wilbur B. Driver Co., Riverside Ave., Newark, N. J.—60-page resistance booklet with tables and charts pertaining to the design and construction of electrical heating units.

Instruments. Foxboro Co., Foxboro, Mass.—Folder DMF666—4 pages describing the means of identifying temperature records and other features of the multi-record potentiometer pyrometer made by this company.

Instruments. H-B Instrument Co., 4518 North Broad St., Philadelphia, Pa.—Bulletin 600—4 pages on this company's indicating dial type and recording thermometers.

Instruments. The Hays Corp., Michigan City, Ind.—Catalog PGA-35—24 pages describing this company's complete line of dry-type pointer draft gages, tube gages and other indicating and recording draft meters.

Materials Handling. Chain Belt Co., 1600 West Bruce St., Milwaukee, Wis.—Bulletin 260—24-page pictorial booklet showing the handling of materials by means of a wide range of equipment made by this company.

Materials Handling. Link-Belt Co., 910 South Michigan Ave., Chicago, Ill.—Folder 1414—4 pages on portable belt conveyors for loading.

Materials Handling. Whiting Corp., Harvey, Ill.—4 pages on equipment for the handling of paper rolls and waste paper.

Metals and Alloys. Aluminum Co. of America, Pittsburgh, Pa.—Form AD 51d—90 pages on aluminum and aluminum alloys with information on properties and uses, together with tabulated engineering data.

Metals and Alloys. Antaciron, Inc., Wellsville, N. Y.—Bull. 101—8 pages describing this company's high-silicon iron alloy, its properties, applications and advantages.

Microscopy. E. Leitz, Inc., 60 East 10th St., New York City—Catalog 18—32 pages on the Leitz Ultropak method of illumination; also supplementary 32-page booklet giving expressions of scientists on this equipment.

Pumps. Foster Pump Works, Inc., 50 Washington St., Brooklyn, N. Y.—Bulletin 1001-2—12 pages describing this company's rotary pumps.

Pumps. Byron Jackson Co., Berkeley, Calif.—Bulletin 359—12 pages on centrifugal pumps including deep-well, multi-stage, close-coupled and mine pumps.

Pumps. Lawrence Machine & Pump Corp., 371 Market St., Lawrence, Mass.—Bulletin 202—4 pages describing the construction of both belt and direct-driven, side-suction centrifugal pumps made by this company.

Rubber. Stamford Rubber Supply Co., Stamford, Conn.—27-page booklet, giving a glossary of terms used in rubber manufacture and discussing advantages of this company's product, Factice.

Rubber Goods. Manhattan Rubber Manufacturing Division, Raybestos-Manhattan, Inc., Passaic, N. J.—56-page general catalog covering this company's complete line of standard rubber products, including hose, fittings, packing, belting, matting, treads, rolls, etc.

Safety. Harrison Engineering Corp., Waterbury, Conn.—Folder describing a new light-weight fire extinguisher using a dry, harmless, fire-extinguishing compound.

Traps. Armstrong Machine Works, Three Rivers, Mich.—Catalog G—28-page book, the third edition of this company's Steam Trap Catalog, complete with many engineering data and much information on the applications and uses of steam traps.

Tubing. Summerill Tubing Co., Bridgeport, Montgomery Co., Pa.—56 pages with descriptions of and engineering data on a wide range of seamless tubing produced by this company. Includes also much valuable general engineering information.

Water Treatment. Rathbun Co., Inc., El Paso, Tex.—Bulletin R-50—6 pages describing this company's water treatment services for ice-plant, power-plant and air-conditioning water.

Chemical Engineering NEWS

F. P. Garvan Heads Farm Chemurgic Council

ORGANIZATION of the Farm Chemurgic Council, with a program designed to advocate use of American farm products as raw materials for manufacturing, was effected last month at a meeting in Chicago of the organization committee appointed at the Dearborn Conference of Agriculture, Industry and Science held last May.

Francis P. Garvan, president of Chemical Foundation, Inc., was elected president of the Council. Other officers are Wheeler McMillen, editor of *Country Home*, first vice president, representing agriculture; Howard E. Coffin, chairman of the board Southeastern Cotton Inc., second vice president, representing industry; Dr. Roger Adams, president American Chemical Society, third vice president, representing science; William W. Buffum, general manager, Chemical Foundation, treasurer; Clifford Gregory, editor of *Prairie Farmer*, secretary; Dr. Harry E. Barnard, director of research and Carl B. Fritsche, managing editor.

Permanent offices of the council will be located at Dearborn, Mich.

Graduate Course in Unit Processes at Brooklyn

A GRADUATE course in organic synthesis consisting of 30 lectures and seminars will be offered at the Polytechnic Institute of Brooklyn beginning Oct. 2. The lectures will be given on Wednesday evenings, under the general direction of Prof. John C. Olson, head of the chemical engineering department.

The course will cover the methods and equipment used in the manufacture of common organic products, the chemical reactions carried out in these processes, also the optimum conditions necessary and the equipment which is in commercial use for carrying out the processes.

The following topics will be covered: nitration, amination by reduction, diazotiazation, sulphonation, halogenation, ammonolysis, oxidation, hydrogenation, alkylation, esterification, and hydrolysis, Friedel and Crafts reaction, polymerization, materials, construction and limitations of use of equipment such as autoclaves, sulphonators, nitrators, etc.

The various topics will be presented by chemical engineers who have specialized in the subjects presented. The following men have consented to give one or more lectures: A. A. Backus, vice-president, U. S. Industrial Alcohol Co.; William C. Bainbridge, chief chemist, H. Kohnstamm & Co.; M. L. Crossley, chief chemist, Calco Chemical Co.; Charles R. Downs, vice-president and treasurer, Weiss and Downs; Wm. Howlett Gardner, research assistant professor of chemical engineering; Philip H. Groggins, senior chemist, Color and Farm Waste Division, U. S. Department of Agriculture; Guy N. Harcourt, manager, New York office, Buffalo Foundry and Machine Co.; Horace T. Herrick, chemist in charge, Color and Farm Waste Division, Bureau of Chemistry and Soils, U. S. Department of Agriculture; Donald F. Othmer, assistant professor of chemical engineering; R. P. Russell, vice-president and general manager, Standard Oil Development Co.; W. A. Simpson, chemical engineer, Charles Pfizer and Co.

Dubbs Cracking Process Upheld in Patent Suit

THE Universal Oil Products Co., owner of the Dubbs cracking process, has won its suit against the Root Refining Co. for infringement of two patents and for damages resulting from the infringement. Three judges sitting in the U. S. Circuit Court of Appeals of the Third Circuit, in Philadelphia, on June 26 handed down a unanimous opinion.

This decision confirms the finding of Judge John P. Nields in the Federal District Court at Wilmington, Del., on April 27, 1934. Judge Nields held that the two patents in suit were valid and were infringed by the operation of so-called Winkler-Koch cracking units in the Root Refining Co.'s plant at El Dorado, Ark. The case was appealed by the defendant. The decision of the Court of Appeals affirms the decree entered by Judge Nields enjoining further operation of the infringing units, and the case will be referred to a master for an accounting and for the assessment of damages.

The Root Refining Co. was a licensee of Universal Oil Products Co., having two Dubbs units which were placed in operation in 1925 and 1926 respectively. Winkler-Koch Engineering Co. later installed at the Root plant the cracking units that the court has found to infringe the Dubbs and Egloff patents.

New Metallic Fabric Offered by duPont

A NEW material making possible non-tarnishable metallic fabrics is announced by the fabrics and finishes department of E. I. du Pont de Nemours & Co. It is made of metallized slit cellulose film, and is manufactured by depositing a non-tarnishable metallic finish on one side of a sheet of Cellophane. Two such sheets are then laminated together, so that each side is metallic coated, and added strength is given to the stock. This sheet is then slit to narrow yarn widths, which then may be woven into a fabric in this form with rayon, silk, wool or cotton. This material is the latest contribution of the chemical industry to the textile world. It is claimed for it that it will not tarnish or oxidize, thus solving a problem which has proved difficult in the production of metallic textiles.

After many tests, it has been found to have a place also in the industrial field. It is adaptable to commercial methods of decorating such as lithographing, silk screen stenciling, embossing, corrugating, creping, shredding and other methods of decoration used in making ribbons, gift ties, window backgrounds, wall coverings and display mediums.

Patent on Alkyd Resins Held Invalid

THE Kienle patent covering a process of making alkyd resins was held to be invalid by the decision of Judge Campbell in the U. S. District Court for the Eastern District of New York, June 12. The patent was the basis of an action by the General Electric Co. against the Paramet Chemical Corp., manufacturers of synthetic resins. The judge ruled that this patent was invalid for want of invention and that certain claims were invalid because broader than the product to which they were applied. He ordered the entering of a decree, with costs, dismissing the bill of complaint for want of equity.

Plans Completed for A.C.S. San Francisco Meeting

PROGRAM for the Ninetieth Meeting of the American Chemical Society has been practically completed. The St. Francis Hotel, San Francisco, has been selected as headquarters for the meeting which will open on Aug. 19 and continue through Aug. 23. The Sir Francis Drake also has been designated as an official hotel and some of the sessions will be held there. The Council Meeting will be held at the St. Francis Hotel at 9.30 Monday morning, Aug. 19. General meetings, divisional meetings, and group luncheons are scheduled throughout the week up to Friday which will be given over to a boat ride and luncheon on San Francisco Bay and to visits to nearby industrial plants.

E. C. Franklin is honorary chairman of the local committee in charge of arrangements and a luncheon in his honor will be served on the opening day of the meeting. Arthur Lachman, Department of Chemistry, University of California is general chairman and P. D. V. Manning is secretary.

The Hawaiian Section has arranged for a post-convention tour to Hawaii. Members who will make this tour will sail from San Francisco on Aug. 24 and will leave Honolulu on Sept. 7 on the return trip.

Patent Pools Attacked In Washington

CHARGING monopolistic tendencies on the part of cross licensing of patents in industrial pools, certain minor units of several industries have been seeking to have these "abuses" investigated and remedied. The first legislative effort made some months ago resulted in a brief hearing before the House Committee on Patents. But the only cases of any consequence discussed related to air craft and nothing came of that effort.

On July 1, however, a proposed investigation was instigated under a resolution introduced by Senator Fletcher of Florida. In that resolution, as proposed, serious charges are made against those manufacturing glass containers, radio and other electrical equipment, signaling devices, and certain office machines, and other commodities. If any substance can be given to the charges which have been made, a substantial inquiry will result and some legislation may be expected next year.

American Economic Foundation, a New York agency said to have certain industrial backing, is pressing this matter in Washington. Whether the present inquiry assumes significant proportions or not, this matter is likely to be aired further from time to time by those who dislike the present management of patent pools.

Grasselli Forms Leather Technical Section

THE Grasselli Chemical Co. announces that it has organized a Leather Technical Section in the experimental laboratory in Cleveland under the direction of George J. Laemmle, who will have a group of experienced chemists to aid him in this work. The objective of the new department will be to study the technology of leather processes, to improve present methods, and to develop new products for the leather industry; as well as to furnish technical service to the trade in connection with the company's products. All of the technical resources of the company will be available to the Leather Technical Section to insure satisfactory results.

Canadian Industries Opens Two New Plants

ACCORDING to a report from H. M. Bankhead, commercial attache at Ottawa, Canadian Industries, Limited, Montreal, has put into operation two new additions to its factories, one located at Cornwall, Ontario, producing liquid caustic soda, liquid chlorine and muriatic acid. They will employ approximately 60 men in this new plant. The other plant is at Shawinigan Falls, Quebec, where they are producing hydrogen peroxide for the first time in Canada. Raw materials for this product are ammonia which comes from Sandwich, Ontario, and sulphuric acid from Copper Cliff, Ontario.

Molasses Exempt From Processing Tax

MOLASSES and syrup made from sugarcane that is surplus under sugarcane adjustment contracts have been exempted from payment of the processing tax, if these products are used for livestock feedstuffs or for distillation. The exemption under sugar regulations, series 1, No. 2, applies mainly to Puerto Rico and the Philippines. In both areas, administrative rulings on the production adjustment contracts provide that sugarcane in excess of that needed to produce the sugar quotas for the area may be ground into molasses or syrup for shipment to the United States to be used for livestock feedstuffs or distillation purposes.

Permanent Exhibit for Metals and Plastics

ON Sept. 1, a permanent exhibit of metals and plastics will be opened at Rockefeller Center, New York, by Metal Products Exhibits, Inc. The exhibition will be devoted wholly to the interests of those who specify and purchase materials and parts for industrial purposes. It will feature alloys, ferrous and non-ferrous metals, plastics, finished and semi-finished parts made from these materials, finishes for metals and plastics, manufacturing processes, designs, styling, etc.

The officers of Metal Products Exhibits, Inc., are: president, F. P. Cummings; vice-president and treasurer, O. H. Simonds; vice-president and general manager, Herbert R. Simonds, products engineer, formerly associate editor of several magazines serving the metal working field, and author of forthcoming McGraw-Hill book on "Finishing Metal Products."

In addition to the officers, the board of directors includes: Philip C. Kemp, and L. W. Hutchins, director of the American Institute and member of the firm of Sheldon, Morse, Hutchins and Easton, Inc.

Robert Krogstad is director of sales for the exhibits company, and F. A. Aubrey and J. V. Schreiber are the design experts. The exhibition has been laid out by Paul McAllister, who designed the arrangement of the Permanent Exhibition of Decorative Arts and Crafts located in the RCA Building, Rockefeller Center.

Oil Companies Enter Into License Agreement

ANNOUNCEMENT is made by Gasoline Products Co. and Sun Oil Co. that they have entered into a new license agreement pertaining to the cracking patents of the two companies. The Sun Oil Co. was one of the first users of the Cross process under license from Gasoline Products Co., granted in 1922. Under the new agreement the Sun Oil Co. has acquired from Gasoline Products Co. a broad immunity and Gasoline Products Co. has obtained the right to grant immunities under the cracking patents of Sun Oil Co.

No announcement was made as to the Sun Oil Co. patents or as to the monetary consideration, but it is understood that substantial cash payments are being made to Gasoline Products Co. and that the Sun Oil Co. has successfully developed and patented an important once-through type of process which will hereafter be available to the licensees of Gasoline Products Co.

NEWS FROM WASHINGTON

By PAUL WOOTON

Washington Correspondent of Chem. & Met.

POLITICAL developments of large business importance are taking form in Washington. They promise to be the real basis of the 1936 campaign. To the casual observer, many of these events seem detached, even unimportant, political controversies. Actually, as a group, they form a picture of large industrial significance.

Taxation seems likely to become one of the major issues involved. Starting as a tax on bigness, the movement is daily gaining momentum and a general revenue measure that will be a genuine tax on business should now be anticipated.

The President suffered a major defeat at the hands of the House of Representatives when that body refused to enact the death sentence section of the public utility holding bill. The significance with reference to holding companies is minor. The determination of Congressional leaders to resume independent legislation is a major result. Only time can determine whether the repudiation of the President's punitive effort is to become the first of a series of independent actions by the Congress.

Apparently the New Deal is in so deep with reference to A.A.A., T.V.A., and other alphabetic activities that it can hardly escape without complete change of plan. The epidemic of injunctions against collection of A.A.A. processing taxes which began the first week of July promises to run a course disastrous to agricultural budget balancing. Thus business in its effort to prove New Deal measures unconstitutional may actually break down the only New Deal agency which has traveled on the "pay as you ride" basis. Perhaps that penalty of new deficits, and hence new taxes, may not be too great to deter the industries affected. The issue will ultimately go with a number of others into the Supreme Court where final adjudication cannot be expected earlier than Christmas, possibly not before next Spring.

Taxes

A graduated tax on corporations with rates scaling upward according to the size in dollars of taxable income will be serious to the chemical industry. The objective sought by the President in making this proposal is clearly a breakdown of large units of business. His reasoning is that corporations with large incomes, like individuals, are better able to pay than those with small incomes. This fallacious reasoning is likely to find popular acceptance. Few will understand that the ability to pay on the part of industry depends largely upon the rate of return on the capital involved, not on mere size of income.

Already there is a definite movement led by trade associations and manufacturers to bring to the attention of industrial stockholders the threat involved in these new tax proposals. It is confidently expected that the country will be flooded by corporations with information aiding their stockholders in an intelligent comment to Congress. A campaign of precisely this nature organized by the public utilities defeated the "death sentence" section of the utility holding-company bill. Congressmen discovered with amazement, then with alarm, that they were representative of investors as well as of farmers, members of organized labor, and other groups. For the first time Washington discovered that depriving the thrifty of their savings was politically inexpedient. This discovery may be very important as a basis for guiding further work in the campaign against taxes on mere bigness.

Trade Problems

Much jockeying under the new N.R.A. procedure develops conclusively the fact that only trade practice limitations can now be effectively formulated and these largely only under the Federal Trade Commission procedure. Labor regulations under this plan are definitely out, not only because of past precedent, but also by Attorney General rulings. Effort to secure compliance with voluntary codes continues somewhat more than half-heartedly.

The President still hopes to have Congress pass a law requiring all bidders on Government contracts to comply with certain wage and employment regulations, substantially those equivalent to the old N.R.A. code limits. Much of the present purchasing is being so limited under Presidential executive order. But full use of this means for securing continued compliance with codes is not possible without some new law.

Wood Chemicals Institute, Inc., has resumed all activity for its industry with complete abandonment of the code authority program. As reorganized, the Institute will have its headquarters office in Washington, where M. H. Haertel will serve it as secretary and treasurer, as well as Washington representative.

National Fertilizer Association has given up altogether its national code and its Washington code-authority organization. Codes by regions will undertake to encourage continuance of code practices in each of the twelve zones established under N.R.A.

The five cents per pound tariff on camphor is continued because domestic synthetic production of this chemical during the six months ending June 17 exceeded 50 per cent of the domestic consumption of camphor. Thus for the third successive year there has been steady growth in the synthetic industry and the five cent duty becomes permanent.

Industrial alcohol supervision was tightened again last month by cancelling of specially denatured alcohol formula 23a for rubbing alcohol and the establishment of a new formula, 23g, on a basis believed to make cleaning much more difficult. Methanol and alcohol interests have continued to press for the reestablishment of a formula based on methanol as a denaturant. At one stage it appeared that a formula using methanol as the principal denaturant, but including also alcotate, Pontol, or other odorous and flavor-giving constituent, would be recommended to the Secretary of the Treasury for approval. However, the formulas believed by officials to be reasonably resistant to cleaning are thus far unacceptable to industrial spokesmen. The old impasse, therefore, continues.

Alcohol legislation to provide some new beverage control agency succeeding F.A.C.A. has remained in the House Committee. The new bill on the President's "must" list has been delayed largely by the controversy over whether the new F.A.C.A. shall be under the Treasury Department or not. Fundamental controversies over industrial alcohol control also continue. It will probably be well into August before this legislation takes sufficiently definite form to permit estimate of the full significance with respect to either industrial alcohol or alcoholic beverages.

Anticipated legislation for control of coal, petroleum, tobacco, cotton, and other commodities has been held up for a long period largely because of the controversies between the White House and Congress. Legislation extending the authority of T.V.A. seems certain of enactment, but with almost as many restrictions as new authorizations. The chance of enactment of the new food and drug bill passed a month ago by the Senate now appears about 50-50.

NEWS FROM ABROAD

By Special Correspondents of Chem. & Met. at London and Berlin

London

AS anticipated the annual meeting of Imperial Chemical Industries, Ltd., resulted in the requisite authority being obtained for the consolidation of the deferred and ordinary shares of this company, but at the meeting of the deferred shareholders there was considerable opposition, which has since resulted in the formation of a shareholders' committee, which will oppose the scheme when it comes before the High Court for ratification. The arguments presented by the two sides in circulars to the shareholders make interesting reading, and it is understandable that the deferred shareholders after waiting so long for their hopes of ultimate large dividends to materialize, are disappointed at a proposal which will definitely limit them for all time. The hearing is expected to result in favor of the company.

Great interest has been shown recently in the shares of Coal & Allied Industries, Ltd., a company originally called Motor Fuel Proprietory, and formed to operate the low temperature carbonization patents of the late Dr. Paul Dvorkovitz. In October, 1933, Harold P. Stevenson was appointed technical advisor to the company, and shortly after the Dvorkovitz patents were discarded, and development work carried out on an alleged revolutionary coal treatment patented process evolved by Mr. Stevenson, who was until 1930 in the employ of I.C.I. as an assistant engineer in their coal-oil division. A 5-ton unit plant was completed in May, 1934, and two college professors have since carried out a more or less secret investigation of the results claimed, which are stated to result in the ultimate production of up to 30 gallons of light oils per ton of coal processed, in addition to the usual 80 per cent yield of smokeless fuel. It must be assumed that the latter is in lump form, but no information is available as to whether the 30 gallons of light oils and certain "valuable chemical products" are obtained directly from the low temperature carbonization of the coal, or whether there is a simultaneous or subsequent hydrogenation or other process resulting in a yield considerably greater than that normally obtainable. In fact, everything is surrounded by considerable secrecy, except the directors' statement that in a plant to treat 500 tons of coal per day, now being built, and said to cost $750,000, the estimated annual profit on the basis of current market prices or less, is to be well over $1,000,000. This works out at about $6 per ton of coal, and it is stated that the plant should be in operation in September or October of this year, and that the commercial plant is merely a multiplicity of the original 5-ton units.

What makes the whole business so interesting is that the ordinary shares of the company of a nominal value of $1.25 gradually appreciated in market value until they stood at over $5 three weeks ago. There has been a further rise since to about $8, partly on the strength of rumors that Imperial Chemical Industries, Ltd., was to take an interest which, as is more than likely, was merely an offer to buy the oil for hydrogenation at Billingham when available. The directors have informed the public that various other liquid products are produced which form the basis of valuable chemical compounds, but so far there is little ground for thinking that the company's processes are on a materially better technical or commercial basis, than those available to other concerns operating in this field, and it remains to be seen whether the expansion of the market in these oils and products, will not ultimately result in lower prices all round. Naturally, the preferential duty on light oils will operate in this company's favor, as it does also in favor of other concerns of this nature, but it seems difficult to reconcile the high price at which the shares now stand, with the ultimate prospects of an organization which has not yet reached its full commercial development, let alone paid a dividend.

The production and use of sodium metasilicate in this country appears to be expanding, the two principal producers being Crosfield & Sons, Ltd., who operate under the processes of the Philadelphia Quartz Co., and Alcock (Peroxide), Ltd., of Luton, who has evolved a distinct process of its own. Sodium metasilicate has probably found its own particular price level now, which is ultimately definitely related to the price of soda ash, but there have certainly been improvements in the manufacture and a reduction in cost, which are likely to promote some further expansion in sales. Messrs. Alcock announce that they are also marketing sodium sesquisilicate.

A new type of rapid coupling for hoses and flexible pipes is being marketed by the Lakealok Coupling Co., Ltd., of London, and while primarily designed for small diameter tubes, it seems capable of application in many new directions. The joint is between rubber, leather or other washers, and its feature is the rapid engagement by means of dogs between the two halves of the coupling, and its automatic locking device. It is stated that the coupling has successfully withstood a liquid pressure of 300 lb. per square inch, but no information is available as to the length of time for which it can be relied upon to remain tight in service.

A new type of drum meter for measuring liquid flow is being placed on the market by Siemens-Schuckert (Great Britain), Ltd., and is said to operate with a limit of error of plus or minus 0.5 per cent under normal conditions. The drum is so designed that the filling of the measuring chambers is always constant whatever the liquid level in the inner cylindrical chambers. The meters are made in six standard sizes, to measure between 250 and 12,000 liters per hour, and can be made in suitable materials for most liquids, chemical stoneware being used when acids are to be measured. The rate of flow is recorded by a standard straight reading counter enclosed in an air and vapor proof cover.

Low Temperature Carbonization, Ltd., is making steady progress, and announces that it has entered into a long term contract for the sale of its low temperature tars and oils to I.C.I. for hydrogenation at Billingham. One of its subsidiary companies at Doncaster has declared an interim dividend of 20 per cent. Low Temperature Carbonization has had a long and checkered career, and was definitely a failure in the early stages. Under its new management and helped by the preferential duty of 8 cents per gallon on home produced oils, the outlook appears encouraging.

Berlin

GERMAN industrial life was grieved and horrified by the recent catastrophal explosion in the Westfalische-Anhaltische Sprengstoff A. G. works at Reinsdorf at Wittenberg; 60 workers were killed and more than 300 received injuries.

The question of raw materials has become an important problem in the ceramic industry, where efforts are being made to replace imported kaolin, clay, and feldspar with domestic materials. Flotation of German granite has been undertaken by Krupp Grusonwerk to determine the possibility of a commercial production of feldspar from that source. The feldspar thus obtained was

found suitable for ceramic mixtures and glass batches, and cost estimates showed that it can compete with imported Scandinavian spar. Concentration of kaolin, chalk, and similar materials has been accomplished in several plants by the use of Hertzsch new continuous centrifuge in which the larger particles are forced to the periphery and removed through small carborundum orifices. Operation of the centrifuge may be adapted to greatly varying conditions and materials. It is made in sizes from 1 to 1.5 m. diameter, 550 to 1,450 r.p.m., and 8-12 hp., with capacities from 8-15 metric tons of dry kaolin per hour. Wear on the orifices amounts to 0.004-0.008 Rm. per ton of kaolin. Concentration of ceramic raw materials contaminated with iron introduced by wear, or iron minerals such as biotite, garnet, limonite, or the like, is done by electromagnetic separation, which, according to G. S. Ullrich, has now been developed to the point where even the finest iron particles may be successfully removed. A combination of flotation and magnetic separation should thus furnish a domestic supply for the feldspar materials required.

Ferrosilicon will soon be available in quantities sufficient to satisfy domestic demands, with the starting of the Knapsack plants of the Rhenish-Wesphalian Electrical Works which up to recently had been closed down.

Metallgesellschaft, Frankfurt A. M., has developed a method for production of sulphuric acid from gases containing sulphur dioxide, involving the use of potassium oxide-vanadium oxide-silica catalyst. The gas mixture is catalyzed in the presence of sufficient steam to form sulphuric acid, and then condensed. If the quantity of steam exceeds that required for formation of H_2SO_4 condensation is carried out with production of strong acid, say 90 per cent. Heat may be added by the use of a direct flame in the contact chamber or by introduction of combustible gases into the contact chamber, with the sulphur gas. Combustion of such gases, containing hydrogen, will produce some of the water needed for the condensation. If cheap fuel is available it is therefore possible to work with very dilute gases, such as industrial and smelter gases. The heat of reaction of this process is nearly three times the heat developed by the reaction $SO_2 + O = SO_3$. (German Patent No. 606,235.) According to German Patent No. 610,448 the sulphur-bearing gases may be obtained by burning hydrogen sulphide or waste gases containing this compound, for instance waste gas from ammonia saturators which may be used directly in the contact furnace, without preliminary drying. The quantity of steam should, if possible, be more than twice that of SO_2 or SO_3. By raising the pressure from 1 to 10 a ton the contact conditions may be still more favorable. (G.P. 610,449).

At the convention of gas and water engineers attention was drawn to the important progress made by the German gas industry during the past year, among which are the use of crude or briqueted lignite for production of city gas; the improvement of city gas by removal of the poisonous carbon monoxide; the remarkable progress in the experiments to use gas for motor fuel as demonstrated by a streamlined auto bus which made a 1,200 km. trip through Germany. In spite of some bad roads the average speed for the trip was 43 km. per hour. Improvements in benzene and sulphur recovery and a great increase in gas consumption, to 4,600,000,000 cu. m. are other indications of the progress made.

Results of tests with wood gas on roads in western Germany have also been obtained. A 32 passenger car with 75 hp. motor and a maximum speed of 55 km. per hour was used. The saving in operating cost compared with an ordinary car was said to be 80 to 85 per cent.

Siemens & Halske have developed a new surface treatment of aluminum, the so called SEO photo process (SEO = Siemens electrolytic oxidation). Dr. Jenny, in an address before the German Chemical Society, pointed to a number of applications of the photograph produced on the aluminum surface which are not possible by ordinary photographic methods, such as the production of all types of signs, scales for brass instruments, slide rules, dials, and the like. SEO photos are also excellent for maps, drawings, and documents. It may also be used in making objects of art, and may permit saving of copper, brass, and German silver. Graining resembling wood or marble may also be produced, for interior decoration of ships, airplanes and railroad cars.

In the SEO process a layer of aluminum oxide serves as carrier for the photo sensitive material, instead of the organic colloid film usually employed. A very pure aluminum, oxidized anodically by the well known Eloxal method, is used in the process. According to the properties desired the Eloxal films are produced in electrolytic baths of oxalic acid, chromic acid, or sulphuric acid. The thickness, porosity, and corrosion resistance of the film may be varied as desired, and the film may be hard and wear resistant or plastic and capable of being shaped. If the photo sensitive material is water soluble, as for instance ammonium ferrinitrate, then the oxidized aluminum sheet may simply be soaked in the solution and dried. When materials insoluble in water are used the sheet must be treated with two solutions in succession, and the photosensitive compound is then produced directly in the pores. Time of exposure may be reduced to fractions of a second. As negatives are not required the method is quite inexpensive.

The chemical treatment after exposure presents no difficulties; fixation and toning are done in the usual manner, except that strengthening with quicksilver must be avoided with aluminum. The finished pictures require a final treatment with oil, paraffin, lacquer, or the like, to close the pores of the Eloxal sheets and prevent finger marks and spots. Decorative effects may be attained by the use of water soluble dyes. If an SEO photo, toned in the usual manner in a gold solution, is heated to 100 deg. C. the black tone of the picture changes into a brownish color; by further heating to about 450 deg. various tones may be produced. Among the advantages of the SEO photos, compared with organic films are their practically unlimited stability to light, resistance to the common organic solvents, hardness, ductility. They are also fire proof. SEO photos may be heated above the melting point of aluminum (658 deg. C.); although the aluminum melts the picture remains on the oxide which lasts up to 1,700 deg. C. A picture on aluminum is hardly any more expensive than an ordinary paper photograph, including the cost of the metal and the cost of oxidation.

New Rosin Certificate To Aid Sellers

A NEW type of Government Rosin Certificate, known as a "Loan and Sale Certificate," and designated for short, "L. S. Certificate," has been provided under an amendment of the Regulations for Enforcement of the Naval Stores Act. These certificates will be issued only on rosin which has previously been regularly graded and marked by a U. S. Naval Stores Inspector-Classifier and is covered by the usual U. S. Rosin Classification and Grade Certificate. An L. S. Certificate is available in case any particular lot of Government graded rosin which it is desired to offer for sale, shipment, export or delivery to a storage warehouse as loan collateral is not exactly described as to quantity or as to grades by any previously issued U. S. Rosin Classification and Grade Certificate.

A new request form has also been provided for use by those wishing to obtain such certificates. This form properly executed will describe and identify the lot of rosin for which an L. S. Certificate is desired, and will also show the intended disposition of the rosin. The fee for issuing L. S. Certificates will be one cent for each barrel or other package covered by a certificate, with a minimum fee of $1.00 for each certificate issued.

NAMES *in the News*

W. LASH MILLER has been made Commander of the Order of the British Empire (Civil Division).

C. R. PAYNE has joined the technical staff of the Atlas Mineral Products Co. at Mertztown, Pa. He had previously been with the Mellon Institute.

CARROLL A. HOCHWALT, vice-president of Thomas & Hochwalt Laboratories, Dayton, Ohio, was honored with the degree of Doctor of Science by the University of Dayton at its recent commencement.

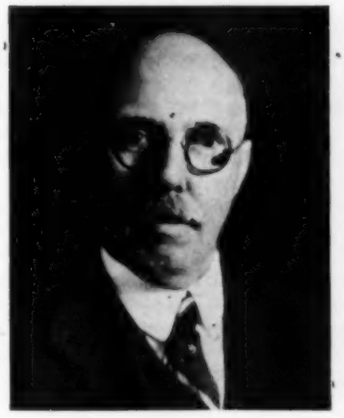
P. J. POTTER has been elected a director and vice-president of the Pangborn Corp., Hagerstown, Md. He will be directly responsible for engineering, sales and production. Mr. Victor F. Stine, who has been with the organization for 23 years, has been elected second vice-president. His long experience with the company has given him knowledge of all the various departments.

IRVING LANGMUIR, of the General Electric Co., has been elected to foreign membership in the Royal Society, one of the highest honors British scientists can bestow on an alien. Dr. Langmuir has, also, been honored recently by the American Society of Mechanical Engineers for his contributions to science and engineering. The Society awarded him the Holley Medal.

WILLIAM H. GESELL, executive vice-president of Lehn and Fink, Bloomfield, N. J., has been designated by the Government as an official delegate to the Sixth International Congress for Scientific Management, to be held in London this month.

WALTER A. WACHHOLTZ has been made director of research for the McCloskey Varnish Co., Philadelphia. He has recently returned from Germany where he lived for two years.

WILLIAM C. WEBER was appointed assistant to the manager of the development department of the Dorr Co., June 1. He will assist Mr. Downes in the handling of the many new development projects.



C. A. Browne

C. A. BROWNE, who has been assistant chief of the Bureau of Chemistry and Soils in charge of chemical and technologic research, retired July 1 from administrative work to devote his time to the research of the Bureau and the publication of research results. Dr. W. W. Skinner, for many years associated with the Bureau, assumes the administrative post left by Dr. Browne. He joined the Department of Agriculture as food inspection chemist in 1904 and four years later became chief of the water laboratory. Since that time he has held various other positions in the Department.

ROBERT C. STANLEY, president of the International Nickel Co. of Canada, has been awarded the honorary degree of Doctor of Engineering by Stevens Institute of Technology.

JAMES S. CARY, formerly associated with Alco Products, is now connected with M. W. Kellogg Co. in the New York office.

FRANK C. VILBRANDT will head the newly created department of chemical engineering at Virginia Polytechnic Institute, Blacksburg. He has been at Iowa State College.

S. S. KISTLER, assistant professor in the chemical engineering department at the University of Illinois, has resigned to become director of research for the Norton Co.

FELIX SINGER has been retained as consulting ceramic engineer by the United States Stoneware Co. of Akron, Ohio.

E. C. KENT has resigned from his position in the research laboratories of the Ionic Industries, Inc., to accept a position with the Pennsylvania Sugar Co., Philadelphia, Pa.

C. T. MELVIN, The Gulf Fertilizer Co., Tampa, Fla., has been elected president of National Fertilizer Association, succeeding John J. Watson, of International Agricultural Corp. The new vice-president is W. T. Wright, F. S. Royster Guano Co., Norfolk, Va., and Charles J. Brand has been re-elected executive secretary and treasurer.

ARTHUR D. CAMP has joined the headquarters staff of the Dorr Co. at New York. He comes to Dorr from Thomas and Hochwalt Laboratories, Dayton, Ohio.

OBITUARY

JOHN W. O'BRIEN, general superintendent of Grasselli Chemical Co., died June 18 at Cleveland, Ohio, after an illness of two months.

WILLIAM LANGSTAFF, formerly superintendent of the Grasselli Chemical Co., Linden, N. J., died at his home in Roselle Park, N. J., June 16 after a short illness. He was 71 years of age. He had also been connected with the Cleveland and East Chicago plants of the company.

CALENDAR

AMERICAN CHEMICAL SOCIETY, San Francisco, week of Aug. 19.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY, fall meeting, Atlantic City, week of Sept. 16.

ELECTROCHEMICAL SOCIETY, semi-annual meeting, Washington, D. C., Oct. 10-12.

AMERICAN PETROLEUM INSTITUTE, annual meeting, Los Angeles, Nov. 11-14.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, annual meeting, Columbus, Ohio, Nov. 13-15.

INTERNATIONAL ACETYLENE ASSOCIATION, annual meeting, Cleveland, Nov. 12-15.

EXPOSITION OF CHEMICAL INDUSTRIES, New York, week of Dec. 2-7.

Chemical ECONOMICS

A FURTHER slight decline in industrial production in May and a decrease in factory employment and pay rolls have been reported by the Federal Reserve Board in its monthly summary of general business and financial conditions. It noted, however, that activity in residential construction continued to be above the level of a year ago.

Volume of industrial production, as measured by the board's seasonally adjusted index, was found to have declined from 86 per cent of the 1923-'25 average in April to 85 per cent in May, which was the fourth consecutive month of gradual decline from the recent high level of 90 in January.

So far as the chemical and related industries are concerned, May operations appear to have been very satisfactory, in fact some producers report business to have been better than in any month so far this year. For instance, sales of paint, varnish and lacquer products in May were valued at $37,055,459 which is a total larger than that for any month since April, 1930. In fact sales for the first five months of this year were larger than those for the corresponding period of any year since 1930.

Production of crude and synthetic methanol in May showed an increase over the respective outputs for the preceding month and the Jan.-May totals for each product are higher than the like totals for last year but the synthetic product is far ahead in the rate of increase.

Manufacturers of plate glass failed to maintain the record rate of operations established in April but the output for May was unusually high and the position of the industry may be inferred from the fact that the Jan.-May production this year reached a total of 75,200,760 sq. ft. as compared with 41,369,190 sq. ft. for the first five months of 1934.

Consumption of crude rubber by manufacturers in the United States for May amounted to 41,568 long tons, which compares with 44,714 long tons for April, 1935. May consumption shows a decrease of 7 per cent below April and 3.1 per cent under May, 1934, according to the Rubber Manufacturers Association. Consumption for May, 1934, was reported to be 42,918 (revised) long tons.

Recent developments in the fertilizer trade are unfavorable from a financial aspect although not changing the outlook which favors a large tonnage movement. Price cutting which was rather common in the industry a few years ago, again has been a factor in the market in some sections of the country.

Fertilizer tax tag sales in 12 Southern States in May, as reported to The National Fertilizer Association, amounted to 236,766 tons. This was the largest quantity reported for any May on record and exceeded sales in May of last year by 54 per cent. The seasonal decline which took place from April to May was less than that which usually occurs, due to the relatively high level of sales in May and to the unusually small April sales.

Sales in the South in the first five months of this year aggregated 3,376,963 tons, an increase of 12 per cent over the corresponding period of last year and 30 per cent over the first five months of 1933. Sales this year, however, have been below 1930, the peak year, and also below 1931.

Deliveries of all sorts of raw silk to domestic mills during June of 33,728 bales ran 4,633 bales under the May total, according to figures furnished by the National Federation of Textiles, Inc. The figure was 659 bales more than during June of last year.

Imports amounted to 38,984 bales during the month, or net 1,448 more than in May and 7,927 more than came in during June, 1934.

Warehouse stocks at the close of June, standing at 42,018 bales, were net 5,256 higher than at the close of May and 17,030 less than at the finish of June a year ago.

Weekly consumption of wool in May averaged about a million pounds more than in April, according to statistics compiled by the Department of Commerce. Consumption per week of apparel wool in May amounted to 6,361,000 lb. (scoured) as against a weekly consumption of 5,454,000 lb. in April and 4,080,000 lb. average for the period from July 1, 1934, to May 31 of this year. Consumption of wool in the first five months of the year in domestic wools amounted to 191,783,000 lb. scoured, or 341,403,000 lb., greasy. Computed on a greasy basis, consumption of wool in May was 46,492,000 lb. (apparel class only). On the same basis, consumption for the first five months of the year was 341,403,000 lb.

Estimates of freight carloadings for the third quarter of 1935 just compiled by the thirteen shippers' regional advisory boards place the total for that period at 2.9 per cent above actual loadings in the same period of 1934.

Declines in loadings for the quarter are estimated for the Southeast, New England, and the Midwest with other districts expected to ship in a larger way than was the case in the third quarter of last year.

Anticipated increases in the movement of some of the commodity groups include: Chemicals and explosives, 7.2 per cent; fertilizers, 7.5 per cent; cottonseed and products except oil, 4.1 per cent; salt, 2.1 per cent; petroleum and products, 3.8 per cent; sugar, syrup and molasses, 5.4 per cent; lime and plaster, 8.4 per cent; paper, paper board and prepared roofing, 6.5 per cent.

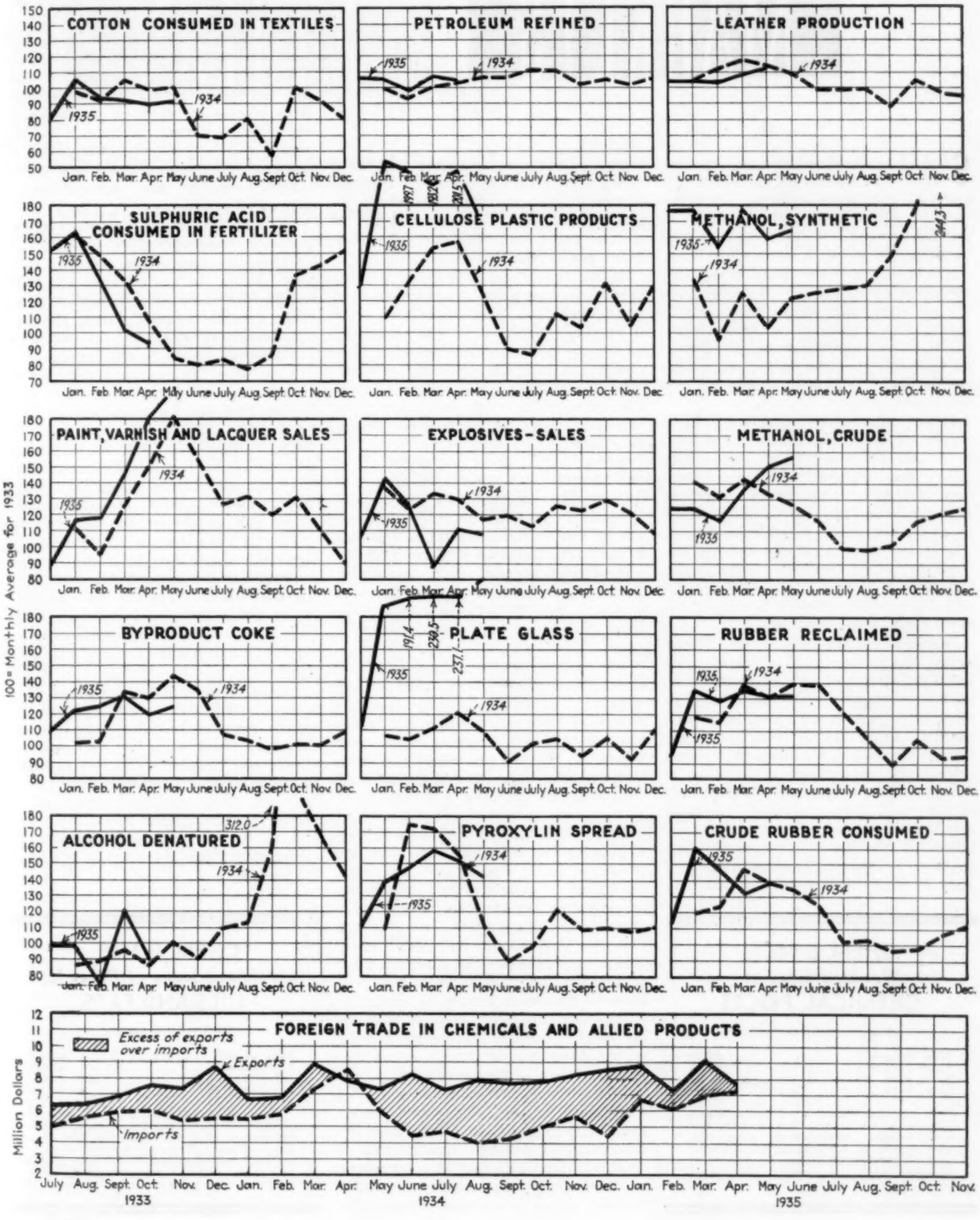
According to the records of *Textile Organon* the rate of rayon deliveries to domestic mills in June was measured by an index number of 376, which compares with 417 in May and a 1934 monthly average of 353. The decline of 10 per cent from May to June was less than seasonal and therefore the corrected index increased from 439 in May to 470 in June.

Production and Consumption Data for Chemical-Consuming Industries

	May 1935	May 1934	Jan.-May 1935	Jan.-May 1934	Gain Jan.-May 1935 over Jan.-May 1934 Per Cent
Production					
Automobiles, No.	364,721	330,455	1,900,817	1,407,786	35.0
Byproduct coke, 1000 tons	2,793	2,670	13,957	13,383	4.3
Glass containers, 1,000 gr.	3,401	3,113	15,034	14,440	4.1
Plate glass, 1,000 sq. ft.	14,582	7,764	75,201	41,369	81.8
Methanol, crude, gal.	403,271	324,063	1,756,736	1,731,227	1.5
Methanol, synthetic, gal.	1,203,143	897,294	6,103,625	4,239,793	43.9
Nitrocellulose plastics, lb.	1,292,273	973,323	6,900,809	5,891,711	17.1
Cellulose-acetate plastics, lb.	717,934	511,851	4,712,250	2,220,882	112.2
Pyroxylin spread, 1,000 lb.	4,280	3,350	22,367	21,368	4.7
Rubber reclaimed, tons	10,223	10,315	51,624	49,462	4.4
Steel barrels, No.	551,882	494,051	2,531,274	3,128,472	19.1*
Consumption					
Cotton, 1,000 bales	469	519	2,438	2,562	4.9*
Silk, bales	38,361	38,740	211,640	200,175	5.7
Explosives, sales, 1,000 lb.	22,659	23,202	107,135	119,086	11.1*
Paint, varnish, and lacquer sales, $1,000	37,055	33,615	141,527	122,728	15.3

*Per cent of decrease.

TRENDS OF PRODUCTION AND CONSUMPTION



The MARKETS

SPOTTY conditions are now encountered in the market for chemicals with seasonal conditions exerting an influence on both sides of the market. In general, demand for raw materials may be described as on a descending scale. Some branches of the chemical industry show a fairly steady rate of manufacturing activity while others have reduced operations. Deliveries of most chemicals to consuming industries have slowed up noticeably in the last three weeks but the lower movement is seasonal and was anticipated.

Prices have shown some irregularity although there has been no general trend in either direction. Some competitive selling has appeared and buyers have been able to pick up certain chemicals at lower levels than were available prior to the court decision affecting NRA. The price tone generally follows the trend in activity and the fact that the hot-weather period has slowed up demand is in itself sufficient to account for the present price condition.

Sulphate of ammonia is one of the items which has sold at lower price levels yet nitrate of soda is quoted at an unchanged figure with the announcement that current quotations have been extended to the end of next November. Prices for mixed fertilizers have been subject to price cutting.

One of the important developments of the month from a trading standpoint was the opening of a futures market for tallow on the floor of the New York Produce Exchange. Trading started on June 26. The contract calls for one tank car of 60,000 pounds of loose tallow entirely of animal fat, untreated and unbleached and of good merchantable quality. Prices are quoted in 1-100 of a cent per pound, equivalent to $6 a point per contract.

While tallow has long been a commodity of importance, it has grown even more important in inedible lines since the processing tax of 3c a lb. went into effect on certain vegetable oils. The result was that the price for oils advanced and demand for tallow was increased very materially and prices were moved up under the more active buying movement.

According to an article published in the Monthly Bulletin of the Banco di Sicilia, the international citric acid agreement signed last year is to last five years. The Italian industry is reported to have been assigned a quota of 38 per cent of the total sales of the signatories to the agreement. It was furthermore agreed to keep the price between a minimum of 4.20 lire and a maximum of 5 lire.

The agreement also covered citrate of lime, and an accord was made for the marketing of citrate of lime, both to members of the group within the agreement and to the outsiders, which will assure this Sicilian raw material a satisfactory outlet. The ratio of the price of citrate of lime to citric acid was fixed at 32 per cent. On the basis of the maximum price of 5 lire for citric acid, this will work out to about 1.60 lire for citrate of lime. During the past year, the Camera Agrumaria paid a premium to citrate of lime producers, who were guaranteed 2 lire per kilo. It is reported that the government will assist citric acid producers to pay the minimum price of 1.60 lire and, furthermore, will continue to guarantee citrate of lime producers to maintain the price of 2.00 lire per kilo by means of a premium to make up the difference during the entire five years duration of the agreement.

In accordance with the provisions of the Tariff Act of 1930, which directs the Tariff Commission to ascertain the percentage of domestic consumption of synthetic camphor supplied by domestic production during three 6-months periods, the Commission has reported returns for 5½ months of the third 6-months' period which ended June 17. The law provides that the present duty of 5c. per lb. shall be continued only if the domestic production of synthetic camphor during this third and last period exceeds 50 per cent of the domestic consumption.

Although the data on consumption of synthetic camphor covers only 5½ of the 6 months, the domestic production during the same period was sufficiently large so that the ratio of production to consumption during the full six months period will undoubtedly exceed the 50 per cent requirement of the law necessary to maintain the existing rate of duty of 5c. per lb.

Domestic manufacturing concerns reported a consumption of 1,102,500 lb. (preliminary figures) of synthetic camphor during the period Dec. 18, 1934, to May 31, 1935. The consumption of crude natural camphor during the first six months of 1935 was in excess of 1,300,000 lb. (preliminary figures).

The ratios of domestic production to consumption of synthetic camphor during the first two 6-months periods, Dec. 18, 1932 to June 17, 1933, and Dec. 18, 1933, to June 17, 1934, as previously determined by the Tariff Commission, were considerably in excess of the requirements for those periods, namely 25 per cent, and 30 per cent, respectively.

The Customs Bureau has directed collectors to assess duty at 20 per cent on importations of linseed oil and other vegetable oil fatty acids entered or withdrawn from bonded warehouse after July 27 under the tariff classification for manufactured articles not specially provided for.

In the opinion of the appraiser fatty acids of vegetable origin are not unsought residues resulting from the refining of crude oils, but they are desirable and valuable subsidiary products in manufacturing operations. The ruling does not affect the tariff status of oil "foots" decided by the court to be subject to 10 per cent, while as to olive oil fatty acids it is the practice to impose 20 per cent.

CHEM. & MET.
Weighted Index of CHEMICAL PRICES

Base = 100 for 1927

This month	**87.23**
Last month	87.45
July, 1934	87.79
July, 1933	86.01

Borax and boric acid commanded higher prices in the last month, but lead oxides, sulphate of ammonia, and spirits of turpentine were lower, and the weighted index number was reduced with the general price tone of the market easier.

CHEM. & MET.
Weighted Index of Prices for OILS AND FATS

Base = 100 for 1927

This month	**87.51**
Last month	92.90
July, 1934	60.54
July, 1933	61.44

Price changes were almost entirely confined to downward revisions. This refers not only to vegetable oils, but also to animal fats. Crude cottonseed oil has declined materially from its high point. Paint-making oils followed the general price trend.

Current PRICES

The following prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to July 11.

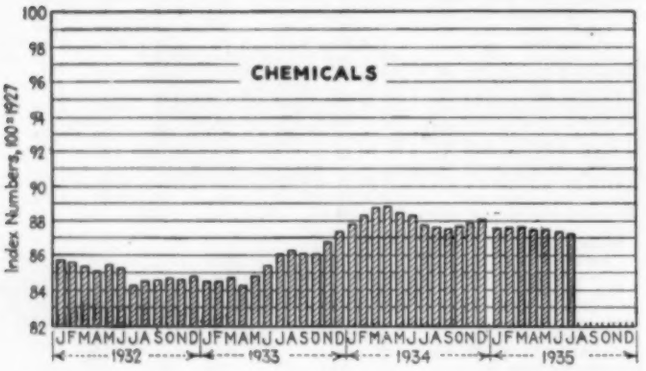
Industrial Chemicals

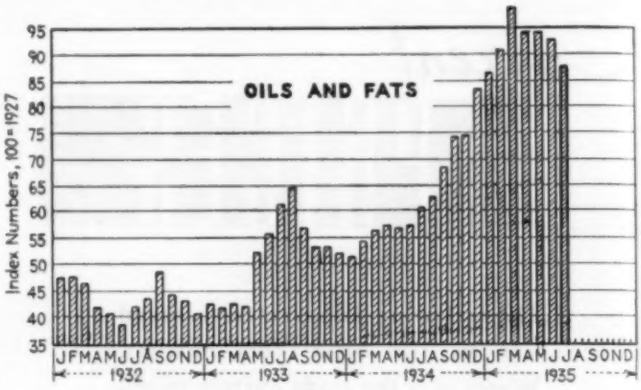
	Current Price	Last Month	Last Year
Acetone, drums, lb.	$0.12 -$0.12½	$0.12 -$0.12½	$0.11 -$0.11½
Acid, acetic, 28%, bbl., cwt.	2.45 - 2.70	2.45 - 2.70	2.76 - 2.90
Glacial 99%, drums	8.43 - 8.68	8.43 - 8.68	10.02 -10.27
U. S. P. reagent	10.52 -10.77	10.52 -10.77	10.52 -10.77
Boric, bbl., ton	105.00-115.00	95.00 -105.00	95.00 -105.00
Citric, kegs, lb.	.28 - .31	.28 - .31	.28 - .31
Formic, bbl., ton	.11 - .11½	.11 - .11½	.11 - .11½
Gallic, tech., bbl., lb.	.60 - .65	.60 - .65	.60 - .65
Hydrofluoric 30% carb., lb.	.07 - .07½	.07 - .07½	.07 - .07½
Lactic, 44%, tech., light, bbl., lb.	.12 - .12½	.12 - .12½	.11½- .12
22%, tech., light, bbl., lb.	.06½- .07	.06½- .07	.06 - .06½
Muriatic, 18° tanks, cwt.	1.00 - 1.10	1.00 - 1.10	1.00 - 1.10
Nitric, 36°, carboys, lb.	.05 - .05½	.05 - .05½	.05 - .05½
Oleum, tanks, wks., ton	18.50 -20.00	18.50 -	18.50 -20.00
Oxalic, crystals, bbl., lb.	.11½- .12½	.11½- .12½	.11½- .12½
Phosphoric, tech., c'boys., lb.	.09 - .10	.09 - .10	.09 - .10
Sulphuric, 60°, tanks, ton	11.00 -11.50	11.00 -11.50	11.00 -11.50
Sulphuric, 66°, tanks, ton	15.50 -	15.50 -	15.50 -
Tannic, tech., bbl., lb.	.23 - .35	.23 - .35	.23 - .35
Tartaric, powd., bbl., lb.	.24 - .25	.24 - .25	.26 - .26½
Tungstic, bbl., lb.	1.50 - 1.60	1.50 - 1.60	1.40 - 1.50
Alcohol Amyl			
From Pentane, tanks, lb.	.15 -	.15 -	.143-
Alcohol Butyl, tanks, lb.	.13 -	.13 -	.095-
Alcohol, Ethyl, 190 p'f., bbl., gal	4.27½-	4.27½-	4.15½-
Denatured, 190 proof			
No. 1 special, dr., gal.	.36 -	.36 -	.346-
No. 5, 188 proof, dr., gal.	.35½-	.35½-	.34 -
Alum, ammonia, lump, bbl., lb.	.03 - .04	.03 - .04	.03 - .04
Chrome, bbl., lb.	.04½- .05	.04½- .05	.04½- .05
Potash, lump, bbl., lb.	.03 - .04	.03 - .04	.03 - .04
Aluminum sulphate, com., bags, cwt.	1.35 - 1.50	1.35 - 1.50	1.35 - 1.50
Iron free, bg., cwt.	1.90 - 2.00	1.90 - 2.00	1.90 - 2.00
Aqua ammonia, 26°, drums, lb.	.02½- .03	.02½- .03	.02½- .03
tanks, lb.	.02½- .02¾	.02½- .02¾	.02½- .02¾
Ammonia, anhydrous, cyl., lb.	.15½- .16	.15½- .16	.15½- .16
tanks, lb.	.04 -	.04½-	.04½-
Ammonium carbonate, powd., tech., casks, lb.	.08 - .12	.08 - .12	.08 - .12
Sulphate, wks., cwt.	1.175-	1.20 -	1.25 -
Amylacetate tech., tanks, lb.	.142-	.142-	.142-
Antimony Oxide, bbl., lb.	.11½- .12	.11½- .12	.08½- .09
Arsenic, white, powd., bbl., lb.	.03½- .04	.03½- .04	.04 - .04½
Red, powd., kegs, lb.	.15½- .16	.15½- .16	.15 - .15½
Barium carbonate, bbl., ton	56.50 -58.00	56.50 -58.00	56.50 -58.00
Chloride, bbl., ton	72.00 -74.00	72.00 -74.00	74.00 -75.00
Nitrate, cask, lb.	.08½- .09	.08½- .09	.08½- .09
Blanc fixe, dry, bbl., lb.	.03½- .04	.03½- .04	.03½- .04
Bleaching powder, f.o.b., wks., drums, cwt.	1.90 - 2.00	1.90 - 2.00	1.85 - 2.00
Borax, grain, bags, ton	44.00 -49.00	40.00 -45.00	40.00 -45.00
Bromine, cs., lb.	.36 - .38	.36 - .38	.36 - .38
Calcium acetate, bags	2.10 -	2.10 -	2.50 -
Arsenate, dr., lb.	.06 - .07	.06 - .07	.05 - .06
Carbide drums, lb.	.05 - .06	.05 - .06	.05 - .06
Chloride, fused, dr., del., ton	20.00 -33.00	20.00 -33.00	17.50 -
flake, dr., del., ton	22.00 -35.00	22.00 -35.00	19.50 -
Phosphate, bbl., lb.	.07½- .08	.07½- .08	.07½- .08
Carbon bisulphide, drums, lb.	.05½- .08½	.05½- .06	.05½- .06
Tetrachloride drums, lb.	.05½- .08½	.05½- .06	.05½- .06
Chlorine, liquid, tanks, wks., lb.	2.00 -	2.00 -	.0185-
Cylinders	.05½- .06	.05½- .06	.05½- .06
Cobalt oxide, cans, lb.	1.35 - 1.40	1.25 - 1.30	1.35 - 1.40
Copperas, bgs., f.o.b. wks., ton	14.00 -15.00	14.00 -15.00	14.00 -15.00
Copper carbonate, bbl., lb.	.08½- .16	.08½- .16	.08½- .16
Cyanide, tech., bbl., lb.	.37 - .38	.37 - .38	.39 - .40
Sulphate, bbl., cwt.	3.85 - 4.00	3.85 - 4.00	3.85 - 4.00
Cream of tartar, bbl., lb.	.16½ - .17	.16½- .17	.19½- .20
Diethylene glycol, dr., lb.	.16½- .20½	.16½- .20½	.14 - .16
Epsom salt, dom., tech., bbl., cwt.	2.10 - 2.15	2.10 - 2.15	2.10 - 2.15
Imp., tech., bags, cwt.	2.00 - 2.10	2.00 - 2.10	2.00 - 2.10
Ethyl acetate, drums, lb.	.08½-	.08½-	.08½-
Formaldehyde, 40%, bbl., lb.	.06 - .07	.06 - .07	.06 - .07
Furfural, dr., contract, lb.	.10 - .17½	.10 - .17½	.10 - .17½
Fusel oil, crude, drums, gal.	.75 -	.75 -	.75 -
Refined, dr., gal.	1.25 - 1.30	1.25 - 1.30	1.25 - 1.30
Glaubers salt, bags, cwt.	1.00 - 1.10	1.00 - 1.10	1.00 - 1.10
Glycerine, c.p., drums, extra, lb.	.14 - .14½	.14 - .14½	.13½- .14
Lead:			
White, basic carbonate, dry casks, lb.	.06½-	.06½-	.06½-
White, basic sulphate, sck., lb.	.06 -	.06 -	.06 -
Red, dry, sck., lb.	.06½-	.06½-	.06½-
Lead acetate, white crys., bbl., lb.	.10½- .11	.10½- .11	.10½- .11
Lead arsenate, powd., bbl., lb.	.09 - .10	.09 - .10	.09 - .13
Lime, chem., bulk, ton	8.50 -	8.50 -	8.50 -
Litharge, pwd., csk., lb.	.05½-	.05½-	.05½-
Lithophone, bags, lb.	.04½- .05	.04½- .05	.04½- .05
Magnesium carb., tech., bags, lb.	.06 - .06½	.06 - .06½	.06 - .06½
Methanol, 95%, tanks, gal.	.33 -	.33 -	.33 -
97%, tanks, gal.	.34 -	.34 -	.34 -
Synthetic, tanks, gal.	.35½-	.35½-	.35½-
Nickel salt, double, bbl., lb.	.12½- 13	.12½- .13	.11½- .12
Orange mineral, csk., lb.	.09½-	.09½-	.09½-
Phosphorus, red, cases, lb.	.44 - .45	.44 - .45	.45 - .46
Yellow, cases, lb.	.28 - .32	.28 - .32	.28 - .32
Potassium bichromate, casks, lb.	.07½- .08½	.07½- .08½	.07½- .08½
Carbonate, 80-85%, calc. csk., lb	.07 - .07½	.07 - .07½	.07 - .07½
Chlorate, powd., lb.	.08½- .09	.08½- .09	.09½- .10
Hydroxide (caustic potash) dr., lb.	.06½- .06½	.06½- .06½	.07½- .08
Muriate, 80% bgs., ton	22.00 -	22.00 -	31.90 -
Nitrate, bbl., lb.	.05½- .06	.05½- .06	.05½- .06
Permanganate, drums, lb.	.18½- .19	.18½- .19	.18½- .19
Prussiate, yellow, casks, lb.	.18 - .19	.18 - .19	.18 - .19
Sal ammoniac, white, casks, lb.	.04½- .05	.04½- .05	.04½- .05
Salsoda, bbl., cwt.	1.00 - 1.05	1.00 - 1.05	1.00 - 1.05
Salt cake, bulk, ton	13.00 -15.00	13.00 -15.00	13.00 -15.00
Soda ash, light, 58%, bags, contract, cwt.	1.23 -	1.23 -	1.23 -
Dense, bags, cwt.	1.25 -	1.25 -	1.25 -
Soda, caustic, 76%, solid, drums, contract, cwt.	2.60 - 3.00	2.60 - 3.00	2.60 - 3.00
Acetate, works, bbl., lb.	.04½- .05	.04½- .05	.04½- .05
Bicarbonate, bbl., cwt.	1.85 - 2.00	1.85 - 2.00	1.85 - 2.00
Bichromate, casks, lb.	.05½- .06½	.05½- .06½	.05½- .06½
Bisulphate, bulk, ton	15.00 -16.00	15.00 -16.00	14.00 -16.00
Bisulphite, bbl., lb.	.03½- .04	.03½- .04	.03 - .04
Chlorate, kegs, lb.	.06½- .06½	.06½- .06½	.06½- .06½
Chloride, tech., ton	12.00 -14.75	12.00 -14.75	12.00 -14.75
Cyanide, cases, dom., lb.	.15½- .16	.15½- .16	.15½- .16
Fluoride, bbl., lb.	.07½- .08	.07½- .08	.07½- .08
Hyposulphite, bbl., lb.	2.40 - 2.50	2.40 - 2.50	2.40 - 2.50
Metasilicate, bbl., cwt.	3.25 - 3.40	3.25 - 3.40	3.25 - 3.40
Nitrate, bags, cwt.	1.275-	1.275-	1.35 -
Nitrite, casks, lb.	.07½- .08	.07½- .08	.07½- .08
Phosphate, dibasic, bbl., lb.	.023- .024	.022- 0.24	.02½- .023
Prussiate, yel. drums, lb.	.11½- .12	.11½- .12	.11½- .02
Silicate (40° dr.) wks. cwt.	.80 - .85	.80 - .85	.80 - .85
Sulphide, fused, 60-62%, dr., lb.	.02½- .03½	.02½- .03	.02½- .03
Sulphite, crys., bbl., lb.	.02½- .02½	.02½ .02½	.03 - .03½
Sulphur, crude at mine, bulk, ton	18.00 -	18.00 -	18.00 -
Chloride, dr., lb.	.03½- .04	.03½- .04	.03½- .04
Dioxide, cyl., lb.	.07 - .07½	.07 - .07½	.07 - .07½
Flour, bag, cwt.	1.60 - 3.00	1.60 - 3.00	1.60 - 3.00
Tin Oxide, bbl. lb.	.54 -	.54 -	.56 -
Crystals, bbl., lb.	.38½-	.38½-	.38½-
Zinc chloride, gran., bbl., lb.	.05 - .06	.05 - .06	.05½- .06
Carbonate, bbl., lb.	.09½- .11	.09½- .11	.09½- .11
Cyanide, dr., lb.	.36 - .38	.36 - .38	.38 - .42
Dust, bbl., lb.	.063- .07	.063- .07	.07 - .07½
Zinc oxide, lead free, bag, lb.	.05½-	.05½-	.06½-
5% lead sulphate, bags, lb.	.05½-	.05½-	.06½-
Sulphate, bbl., cwt.	2.75 - 3.00	2.75 - 3.00	3.00 - 3.25

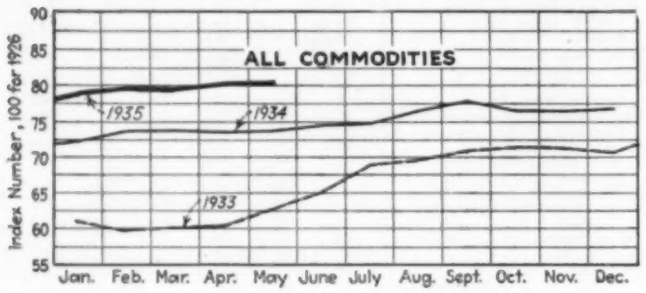
Oils and Fats

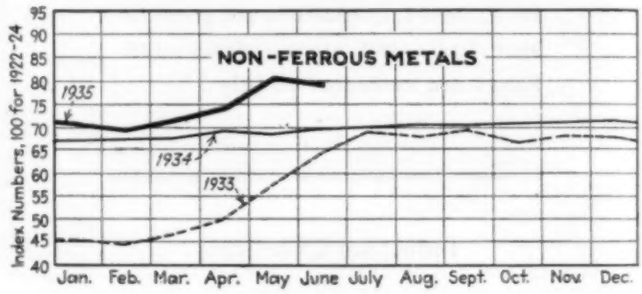
	Current Price	Last Month	Last Year
Castor oil, No. 3, bbl., lb.	$0.09½-$0.10	$0.09½-$0.10	$0.09½-$0.10
Chinawood oil, bbl., lb.	.15 -	.18 -	.09½-
Coconut oil, Ceylon, tanks, N. Y. lb.	.03½-	.04½-	.02½-
Corn oil crude, tanks, (f.o.b. mill), lb	.08½-	.08½-	.05½-
Cottonseed oil, crude (f.o.b. mill), tanks, lb.	.08½-	.09 -	.04½-
Linseed oil, raw car lots, bbl., lb.	.093-	.097-	.097-
Palm, casks, lb.	.04½-	.04½-	.03½-
Palm Kernel, bbl., lb.	.05½-	.05½-	.03½-
Peanut oil, crude, tanks (mill), lb.	.09½-	.09½-	.05½-
Rapeseed oil, refined, bbl., gal.	.42 - .43	.45 - .46	.37 - .38
Soya bean, tank, lb.	.093-	.09 -	.06½-
Sulphur (olive foots), bbl., lb.	.08 -	.08½-	.07½-
Cod, Newfoundland, bbl., gal.	.35 -	.33 -	nom.
Menhaden, light pressed, bbl., lb;	.067-	.067-	.051-
Crude, tanks (f.o.b. factory), gal.	.28 -	.30 -	.16 -
Grease, yellow, loose, lb.	.06½-	.06½-	.03½-
Oleo stearine, lb.	.09 -	.09 -	.05½-
Red oil, distilled, d.p. bbl., lb.	.09½-	.09½-	.07 -
Tallow, extra, loose, lb.	.06½-	.07½-	.03½-

CHEM. & MET.'S WEIGHTED PRICE INDEXES









Coal-Tar Products

	Current Price	Last Month	Last Year
Alpha-naphthol, crude, bbl., lb.	$0.60 -$0.65	$0.60 -$0.65	$0.60 -$0.62
Refined, bbl., lb.	.80 - .85	.80 - .85	.80 - .85
Alpha-naphthylamine, bbl., lb.	.32 - .34	.32 - .34	.32 - .34
Aniline oil, drums, extra, lb.	.14½- .15	.14½- .15	.14½- .15
Aniline salts, bbl., lb.	.24 - .25	.24 - .25	.24 - .52
Benzaldehyde, U.S.P., dr., lb.	1.10 - 1.25	1.10 - 1.25	1.10 - 1.25
Benzidine base, bbl., lb.	.65 - .67	.65 - .67	.65 - .67
Benzoic acid, U.S.P., kgs, lb.	.48 - .52	.48 - .52	.48 - .52
Benzyl chloride, tech., dr., lb.	.30 - .35	.30 - .35	.30 - .35
Benzol, 90% tanks, works, gal.	.15 - .16	.15 - .16	.20½- .21
Beta-naphthol, tech., drums, lb.	.22 - .24	.22 - .24	.22 - .24
Cresol, U.S.P., dr., lb.	.11 - .11½	.11 - .11½	.11- .11½
Cresylic acid, 97%, dr., wks., gal.	.45 - .46	.42 - .43	.50 - .51
Diethylaniline, dr., lb.	.55 - .58	.55 - .58	.55 - .58
Dinitrophenol, bbl., lb.	.29 - .30	.29 - .30	.29 - .30
Dinitrotoluen, bbl. lb.	.16 - .17	.16 - .17	.16 - .17
Dip oil 25% dr., gal.	.23 - .25	.23 - .25	.23 - .25
Diphenylamine, bbl., lb.	.38 - .40	.38 - .40	.38 - .40
H-acid, bbl., lb.	.65 - .70	.65 - .70	.65 - .70
Naphthalene, flake, bbl., lb.	.05½- .06½	.05½- .06½	.06 - .07
Nitrobensene, dr., lb.	.08½- .09	.08½- .09	.08½- .10
Para-nitraniline, bbl., lb.	.51 - .55	.51 - .55	.51 - .55
Phenol, U.S.P., drums, lb.	.14½- .15	.14½- .15	.14½- .15
Picric acid, bbl., lb.	.30 - .40	.30 - .40	.30 - .40
Pyridine, dr., gal.	1.10 - 1.15	1.10 - 1.15	.90 - .95
Resorcinal, tech., kegs, lb.	.65 - .70	.65 - .70	.65 - .70
Salicylic acid, tech., bbl., lb.	.40 - .42	.40 - .42	.40 - .42
Solvent naphtha, w.w., tanks, gal.	.26 -.....	.26 -.....	.26 -.....
Tolidine, bbl., lb.	.88 - .90	.88 - .90	.88 - .90
Toluene, tanks, works, gal.	.30 -.....	.30 -.....	.30 -.....
Xylene, comm., tanks, gal.	.30 -.....	.30 -.....	.26 -.....

Miscellaneous

	Current Price	Last Month	Last Year
Barytes, grd., white, bbl., ton.	$22.00-$25.00	$22.00-$25.00	$22.00-$25.00
Casein, tech., bbl., lb.	.11½- .13	.12 - .14	.12½- .13
China clay, dom., f.o.b mine, ton	8.00 -20.00	8.00 -20.00	8.00 -20.00
Dry colors:			
Carbon gas, black (wks.), lb.	.04 - .20	.04 - .20	.04 - .20
Prussian blue, bbl., lb.	.36½- .38	.36½- .38	.35½- .37
Ultramine blue, bbl., lb.	.06 - .32	.06 - .32	.06 - .32
Chrome green, bbl., lb.	.26 - .27	.26 - .27	.26 - .27
Carmine red, tins, lb.	4.00 - 4.40	4.00 - 4.40	4.00 - 4.40
Para toner, lb.	.80 - .85	.80 - .85	.80 - .85
Vermilion, English, bbl., lb.	1.52 - 1.55	1.52 - 1.55	1.58 - 1.60
Chrome yellow, C. P., bbl., lb.	.15 - .16	.15 - .15½	.15 - .15½
Feldspar, No. 1 (f.o.b. N.C.), ton	6.50 - 7.50	6.50 - 7.50	6.50 - 7.50
Graphite, Ceylon, lump, bbl., lb.	.07 - .08½	.07 - .08½	.07 - .08½
Gum copal Congo, bags, lb.	.09 - .10	.09 - .10	.06 - .08
Manila, bags, lb.	.09 - .10	.09 - .10	.16 - .17
Damar, Batavia, cases, lb.	.15½- .16	.15½- .16	.16 - .16½
Kauri No. 1 cases, lb.	.20 - .25	.20 - .25	.45 - .48
Kieselguhr (f.o.b. N.Y.), ton.	50.00 -55.00	50.00 -55.00	50.00 -55.00
Magnesite, calc, ton	50.00 -.....	50.00 -.....	40.00 -.....
Pumice stone, lump, bbl., lb.	.05 - .07	.05 - .08	.05 - .07
Imported, casks, lb.	.03 - .40	.03 - .40	.03 - .35
Rosin, H., bbl.	5.60 -.....	5.65 -.....	5.35 -.....
Turpentine, gal.	.48½	.50½-.....	.47½-.....
Shellac, orange, fine, bags, lb.	.25 -.....	.25 -.....	.35 -.....
Bleached, bonedry, bags, lb.	.21 - .22	.21 - .22	.32 - .33
T. N. bags, lb.	.14- .15	.14 - .15	.26 - .27
Soapstone (f.o.b. Vt.), bags, ton	10.00 -12.00	10.00 -12.00	10.00 -12.00
Talc, 200 mesh (f.o.b. Vt.), ton.	8.00 - 8.50	8.00 - 8.50	8.00 - 8.50
300 mesh (f.o.b Ga.), ton.	7.50 -10.00	7.50 -10.00	7.50 -11.00
225 mesh (f.o.b. N. Y.), ton.	13.75 -....	13.75 -.....	13.75 -.....

INDUSTRIAL NOTES

HARRISBURG PIPE & PIPE BENDING CO., Harrisburg, Pa., has changed its corporate name and now is called the Harrisburg Steel Corp.

AMERICAN SHEET AND TIN PLATE CO., Pittsburgh, has transferred O. E. Romig from the plant at Gary, Ind. to the general offices in Pittsburgh where he will act as manager of the electrical sheet division. James P. Barton has been appointed sales manager of this division.

E. I. DUPONT DE NEMOURS & CO., Wilmington, are offering five new dyestuffs. These include Acele Diazo Navy RD, Sulfogene Red Brown 6RCF, Ponsol Golden Orange 4G Paste (Pat.), Sulfanthrene Black PG Double Paste, Diagen Blue MGR and Diagen Blue MGR 20 per cent solution.

THE GRAY INDUSTRIAL LABORATORIES, Newark, N. J., has announced the establishment of an X-ray department for the inspection and testing of materials. Assembly, installation and operation of equipment are under the direction of Robert C. Woods, formerly of the X-ray and radium research department of the Memorial Hospital, New York.

STANDARD FUEL ENGINEERING CO., Detroit, has appointed the E. B. Packard Co., 30 Church St., New York, as representatives in the New York territory.

READ MACHINERY CO., York, Pa., has placed M. B. Skipper in charge of sales in the Chicago territory. Mr. Skipper will have his headquarters with Goggin and Mills, 407 So. Dearborn St., Chicago.

WISHNICK-TUMPEER, INC., New York, has incorporated an associate company, WITCO Limited, in England. Offices are in Bush House, London with T. F. Dunn, Jr., managing director and C. C. Hallett, secretary and sales manager.

PRODUCTIVE EQUIPMENT CORP., Chicago, is represented in the Michigan territory by Eddy & Cuthbert whose new address is 709 So. Washington Ave., Lansing.

WESTVACO CHLORINE PRODUCTS CORP., South Charleston, W. Va., has acquired the property in that place, formerly occupied by the Calco Chemical Co.

New CONSTRUCTION

Where Plants Are Being Built in Process Industries

	Current Projects		Cumulative 1935	
	Proposed Work	Contracts	Proposed Work	Contracts
New England	$58,000	$28,000	$867,000	$315,000
Middle Atlantic	228,000	718,000	2,687,000	1,620,000
South	518,000	241,000	6,840,000	5,377,000
Middle West	1,158,000	678,000	8,324,000	6,736,000
West of Mississippi	553,000	56,000	4,670,000	3,311,000
Far West	.....	138,000	1,575,000	5,608,000
Canada	827,000	1,250,000	6,845,000	1,320,000
Total	$3,342,000	$3,129,000	$31,808,000	$24,287,000

PROPOSED WORK BIDS ASKED

Acetic Acid Plant—Tennessee Products Corp., Wrigley, Tenn., contemplates alterations to its acetic acid plant. Estimated cost $150,000.

Chemical Factory—Electric Reduction Co. of Canada, Ltd., Buckingham, Que., Can., plans construction of a chemical factory. Francis G. Bush, Montreal, Que., Pres.

Chemical Factory—Oxford Process Corp., c/o Alfred Ashworth, Smethport, Pa., contemplates the construction of a factory at Buffalo, N. Y. Maturity indefinite. Estimated cost $28,500 or more.

China Factory—Hall China Co., East Liverpool, O., will soon take bids for two brick and steel factory buildings; one 80x100 ft. and other 110x480 ft. B. H. Prack, Martin Bldg., Pittsburgh, N. S., Pa., archt.

China Factory—Homer Laughlin China Co., Newell, W. Va., plans to construct 1 story, 45x120 ft. addition to Building No. 4 to be used for straw and storage purposes. Estimated cost $40,000.

Cotton Oil Plant—Swift & Co., Union Stock Yards, Chicago, Ill., has purchased the plant of the LaGrange Cotton Oil Co., LaGrange, Ga., and will improve same for its own use. Estimated cost including equipment $28,000.

Distillery—Lynchburg Distilling Co., Lynchburg, O., plans to recondition and install new equipment in its distillery. J. L. Bennett, Pres. Estimated cost $250,000.

Distillery—Ozark Distillers, Inc., Fort Smith, Ark., A. S. Bullock, Secy., will construct a brandy distillery on the Arkansas River at Fort Smith instead of at Springdale, Ark., as at first planned. Estimated cost exceeds $28,000.

Factory—Air Reduction Sales Co., 1600 South Agnew St., Oklahoma City, Okla., has had plans prepared for a 44x60 ft. addition to its plant. Estimated cost $25,000.

Fertilizer Plant—Baugh & Sons, Portsmouth, Va., plan to repair their fertilizer plant recently damaged by fire with a loss of $300,000.

Graphite Plant—U. S. Graphite Co., Saginaw, Mich., plans to construct a 1 story, 68x120 ft. addition to its plant. Franz & Spence, Saginaw, archts. Estimated cost including equipment $28,000.

Gasoline Refinery—Corporation, c/o D. Fortney, Mt. Pleasant, Mich., plans to construct a gasoline refinery at Salzburg, Mich. Estimated cost $300,000.

Gasoline Distilling Plant—E. I. du Pont de Nemours & Co., Wilmington, Del., plans to repair its plant at Deepwater, N. J., recently damaged by fire and explosion. Estimated cost $50,000.

Oil Refinery—Shell Petroleum Corp., Wood River, Ill., plans to recondition and construct additions to its refinery here, including cracking unit. Estimated cost to exceed $500,000.

Oil Refinery—Shell Petroleum Corp., Arkansas City, Ark., plans to recondition its refinery including the cracking units. Estimated cost to exceed $500,000.

Rayon Mill—Celanese Corporation of America, 180 Madison Ave., New York, N. Y., manufacturer of viscose rayon products, plans to construct additions to its mill at Amcelle, near Cumberland, Md. Estimated cost including equipment $150,000.

Tannery — Fleckinstein Tannery, Muskegon, Mich., contemplates the construction of a tannery. Estimated cost exceeds $30,000. Maturity indefinite.

Storage Building — Eastern Distributors, Lewiston, Me., contemplate the construction of a liquor storage building. Estimated cost including equipment $28,000.

Sugar Refinery — Negotiations are being carried on between the Manitoba Provincial Government and several sugar companies with a view to completing arrangements for financing the proposed Manitoba beet sugar project. The government has announced its readiness to guarantee bonds up to $600,000 for construction of a factory in the province. The Industrial Development Board of Manitoba is interested in the project.

Glue Factory—Canada Glue Co. Ltd., Brantford, Ont., Can., plans to construct an addition to its plant. W. J. Feldkamp, engr. Estimated cost $25,000.

CONTRACTS AWARDED

Abrasives Factory — Canadian Durex Abrasives, Ltd., Canal Rd., Brantford, Ont., Can., awarded contract for 4 story addition to factory, to Cromar Construction Co., 448 Colborne St., Brantford. Estimated cost $50,000.

Aluminum Factory — Aluminum Co. of Canada, Arvida, Que., Can., will construct an aluminum factory. Work will be done by separate contracts. Contract for about 1,000 tons structural steel has been let to Dominion Bridge Co., 1135 Beaver Hall Hill, Montreal, Que., Can. Estimated cost $1,000,000.

Chemical Plant — Monsanto Chemical Co., 1700 South 2nd St., St. Louis, Mo., awarded contract for addition to chemical plant at Monsanto, Ill., to United Engineers & Constructors, 1401 Arch St., Philadelphia, Pa. Estimated cost $500,000.

Chemical Plant—Paper Makers Chemical Co., c/o H. M. Thompson, East Point, Ga., plans to construct an addition to its chemical plant. Work will be done by day labor.

China Factory—Sterling China Co., Wellsville, O., awarded contract for factory to include 1 story, 80x120 ft. and 1 story, 90x150 ft. buildings, 1 story, 20x40 ft. frit house and two continuous kilns, to D. F. Nellis & Sons, East Liverpool, O.

Distillery—Coffey Distilling Co., Fisherville, Ky., and 515 Juanita St., Louisville, Ky., will build a distillery. Work will be done by day labor and separate contracts. Estimated cost $50,000.

Distillery—Waterfill & Frazier, W. Dowling, pres., Tyrone, Ky., plans to rehabilitate its distillery. Separate contracts have been awarded for the work. Estimated cost to exceed $28,000.

Distillery — Ripy Bros., Ernest Ripy, Pres., Lawrenceburg, Ky., plan to construct a distillery. Separate contracts are now being awarded. Estimated cost $30,000.

Enameling Plant — Gaffers & Sattler, 4561 East 50th St., Los Angeles, Calif., awarded contract for enameling plant to W. P. Neil, 4814 Loma Vista St., Los Angeles, Calif. Estimated cost $80,000.

Factory—W. P. Fuller Co., 2nd and Jackson Sts., Seattle, Wash., awarded contract for altering plant formerly occupied by Ford Motor Co., to Hoard Engineering Co., 6740 Fox St., Seattle. The company will use the plant for paint and glass distribution.

Oil Refinery—Canfield Oil Co., Coraopolis, Pa., awarded contract for rebuilding its refinery recently damaged by fire to Austin Co., Union Trust Bldg., Philadelphia, Pa.

Rubber Factory—Hodgman Rubber Co., Herbert St., Framingham, Mass., awarded contract for additions to Buildings Nos. 4 and 7, to Julius J. Conviser, 333 Washington St., Boston, Mass. Estimated cost to exceed $28,500.

Rubber Factory—Industrial Rubber Co., St. Joseph, Mo., awarded contract for rubber products factory to M. W. Stock & Son, St. Joseph, Mo.

Soap Factory—Proctor & Gamble, Ivorydale, O., will construct additions and improvements to its factory. Work will be done by day labor and separate contracts.

Soap Factory—Royal Crown Soaps Ltd., King at Henry Sts., Winnipeg, Man., Can., awarded contract for factory to Fraser & McDonald, 911 Somerset Bldg., Winnipeg. Estimated cost $200,000.

Varnish Factory—Price-Powell Varnish Co., Valley Park, Mo., awarded contract for addition to factory at 3rd and Marshall Sts., to Parnell Quick, 240 West Big Bend Blvd., Webster Groves, Mo.

Storage Tank—U. S. Industrial Alcohol Co., Curtis Bay, Baltimore, Md., awarded contract for 3,000,000 gal. storage tank at Curtis Bay, to McClintic-Marshall Co., Mercantile Trust Bldg., Baltimore. Estimated cost $20,000.

Storage Building — Century Distilling Co., Peoria, Ill., will build 10 story storage building and rack house. Separate contracts have been awarded. Estimated cost $100,000.

Warehouse—Joseph S. Finch & Co., Schenley, Pa., awarded contract for distillery warehouse to Frank Messer & Sons, Cincinnati, O. Estimated cost $500,000.

Warehouse — Kent Taylor Distillery Co., Frankfort, Ky., will build warehouse. Separate contracts are now being awarded by Leslie & Abbott, Archts., Louisville, Ky. Estimated cost $125,000.

Warehouse—Krebs Pigment Corp., 2001 Benhill Rd., Baltimore, Md., will build 4 story warehouse by day labor. Estimated cost $40,000.

Warehouse—Owings Mills Distillery, Owings Mills, Md., awarded contract for 6 story rack warehouse to G. Walter Tovell, Eutaw and Monument Sts., Baltimore, Md. Estimated cost $60,000.

Warehouse—U. S. Paper Co., 1301 East 6th St., Los Angeles, Calif., awarded contract for warehouse and office building on Evergreen St. and Pico Blvd. to W. P. Neil Co., 4814 Loma Vista St., Los Angeles. $30,000.

Warehouse — Wright Distilling Co., Lorelei, Md., awarded contract for 4 story warheouse to G. Walter Tovell, Eutaw and Monument Sts., Baltimore, Md. $70,000.

Decline in Domestic Production of Dyes Last Year

DUE to consumers building up stocks in the preceding year in anticipation of higher prices, domestic production of coal-tar dyes in 1934 dropped to 87,178,000 lb.—a drop of 13.6 per cent from the 1933 total—according to a report made by the U. S. Tariff Commission. On the other hand, increases in output were noted for most other coal-tar groups. Outstanding are the increases in coal-tar resins and synthetic non-coal-tar chemicals.

In addition to the drop in production of dyes a corresponding decrease in the volume of sales and a slight increase in the value of sales of dyes is noted. The average unit value of sales of all dyes in 1934 was 51c. per lb. as against 44c. in 1933. The decrease in volume and increase in unit value of sales are due entirely to decreased sales of the low-priced tonnage dyes—indigo paste and sulphur black. Indigo output declined to 15,818,000 lb. from 23,412,400 lb. in 1933 or 32 per cent, and sulphur black production decreased from 16,020,531 lb. in 1933 to 9,790,000 lb. in 1934 or 39 per cent. These decreases are due to consumers building up stocks the preceding year because of anticipated increases in prices, and to decreased exports to China. Exports of dyes to China decreased from 11,591,637 lb. in 1933 to 8,373,975 lb. in 1934. Sales of unclassified dyes included in this total increased to 8,701,000 lb. valued at $8,962,000 or 12 per cent in volume and 15 per cent in value. Most of the new developments are reflected in this group, such as the dyes for synthetic fibers, cast phenolic resins, and specialty types for the textile industry.

Output of coal-tar intermediates reached the all-time peak of 407,728,000 lb. or 10 per cent increase over 1933 and more than 50 per cent increase over the period 1925-30. Production of phenol increased 35 per cent, phthalic anhydride 47 per cent, ortho dichlorobenzene 55 per cent and para dichlorobenzene 28 per cent over 1933. Increased production is also shown for acetanilide, tech., b-amino-anthraquinone, Chicago acid, H acid, J acid, dibutyl phthalate, alpha naphthol, nitrobenzene, sulphanilic acid and others. Decreased production is shown for refined naphthalene, aniline oil, gamma acid, benzanthrone, refined cresylic acid, dimethylaniline, dinitrochlorobenzene and phenylglycine.

Remarkable increases in production of coal-tar resins are again noted. Output increased 34 per cent over the preceding year to a total of 55,708,000 lb. Resins derived from phenol and cresol increased 28 per cent and those derived from phthalic anhydride increased 50 per cent in volume. Increased production is shown for resins derived from maleic acid and commercial production of resins from styrol and from xylenols are reported for the first time.

In the field of synthetic organic chemicals not of coal-tar origin the output reached an all time high of 1,133,719,000 lb. or 47 per cent increase in volume as compared with 1933. Increases in acetic acid and related products are outstanding, such as synthetic acetic acid more than 40 per cent increase in volume, acetaldehyde 53 per cent, acetic anhydride 16 per cent, butyl acetate 29 per cent, ethyl acetate 16 per cent, and amyl acetate 79 per cent. Production of synthetic ethyl alcohol increased more than 25 per cent, synthetic methanol 29 per cent, and butyl alcohol 24 per cent. Dry cleaning solvents continue to show sharp increases, such as carbon tetrachloride 31 per cent and trichloroethylene more than 70 per cent. Formaldehyde output increased appreciably, tetraethyl lead more than 40 per cent and isopropyl alcohol more than 300 per cent. Remarkable increases are shown for ethylene derivatives, synthetic camphor, sulphated fatty alcohols and fatty acids, isopropyl ether, lactic acid and synthetic rubber.

Production and sales of dyes and other synthetic organic chemicals, 1925-30, 1933, and 1934

	1925-30 Average 1000 Lb.	1933 1000 Lb.	1934 1000 Lb.
Intermediates:			
Production	267,492	370,754	407,728
Sales	109,133	163,683	174,664
Finished coal-tar products:[1]			
Production	138,078	[2]176,206	186,629
Sales	133,964	[2]162,092	167,632
Dyes:			
Production	94,003	100,953	87,178
Sales	92,207	98,238	84,309
Medicinals:			
Production	4,508	8,715	10,022
Sales	4,106	8,070	8,224
Flavors and perfume materials:			
Production	3,966	3,159	4,168
Sales	3,919	2,965	3,695
Coal-tar resins (1927-30):			
Production	24,442	[2]41,628	[2]55,708
Sales	22,135	[2]31,658	[2]43,351
Synthetic non-coal-tar chemicals:			
Production	379,972	771,575	1,133,719
Sales	264,006	542,679	639,410
Non-coal-tar resins:			
Production	No data	3,572	.....
Sales		3,256	3,558

[1]Includes color lakes, photographic chemicals and miscellaneous coal-tar products not shown separately.
[2]Does not include coumarone and indene resins.

Synthetic coal-tar resins[1]: Production and sales, 1934

	Production 1000 Lb.	Sales 1000 Lb.
Total[2]	55,708	43,351
Derived from phenol:		
Cast	4,968	4,794
Other	24,800	23,201
Derived from cresol and/or phenol	10,887	8,091
Derived from phthalic anhydride	14,877	7,085
Derived from maleic acid:		
Styrol, Xylenol	177	180

[1]For synthetic resins of non-coal-tar origin, the report has separate data.
[2]Does not include resins derived from coumarone and indene.

PRODUCTION AND SALES OF CERTAIN SYNTHETIC ORGANIC CHEMICALS OF NON-COAL-TAR ORIGIN, 1934

Industrial and miscellaneous synthetic organic chemicals

	Total Production Pounds	Sales		
		Quantity Pounds	Value	Unit Value
Total	1,133,719,000	639,410,000	$72,878,000	$0.11
Acetaldehyde	62,523,000	.....	.....	.....
Acetic anhydride (from all sources)	67,335,000	7,136,000	929,000	.13
Amyl acetate	8,098,000	8,227,000	812,000	.10
Amyl alcohol (iso, sec and ter)	1,063,000	826,000	105,000	.13
Butyl acetate (n, iso, and sec)	42,112,000	43,339,000	3,968,000	.09
Butyl alcohol (n, iso, sec, and ter)	49,082,000	36,457,000	3,145,000	.09
Carbon tetrachloride	46,920,000	42,576,000	1,748,000	.04
Chloroform, tech. and USP	1,782,000	1,434,000	233,000	.16
Citral	15,000	13,000	29,000	2.20
Citronellol	15,000	12,000	20,000	1.64
Ethyl acetate (85 per cent)	47,671,000	23,275,000	1,662,000	.07
Ethyl butyrate	28,000	24,000	17,000	.72
Ethyl chloride, tech. and USP	39,040,000	.....	.....	.....
Ethyl ether, tech., USP, and absolute	8,184,000	6,801,000	1,445,000	.21
Ethyl isovalerate	.....	564	1,069	1.90
Ethyl valerate	1,450	543	800	1.47
Gallic acid, tech	118,000	.....	.....	.....
Geraniol	186,000	163,000	230,000	1.41
Heliotropin	.....	15,000	22,000	1.49
Isoamyl butyrate	7,094	7,460	5,972	.80
Isoamyl formate	.....	296	302	1.02
Methanol (synthetic)	85,565,000	64,451,000	3,189,000	.05
Oxalic acid	8,922,000	7,968,000	845,000	.11
Pyrogallol (pyrogallic acid)	83,000	85,000	126,000	1.48
Rhodinol	3,374	2,420	34,518	14.26
Zinc dimethyldithiocarbamate	13,120	8,420	17,279	2.05
Total	.....	635,387,000	$70,154,000	$0.11